# MECHANICAL ENGINEERING

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A.S.M.E. ANNUAL MEETING—NEW YORK, N. Y.—NOVEMBER 26-29, 1945

# REPORT FROM RIVERSIDE:

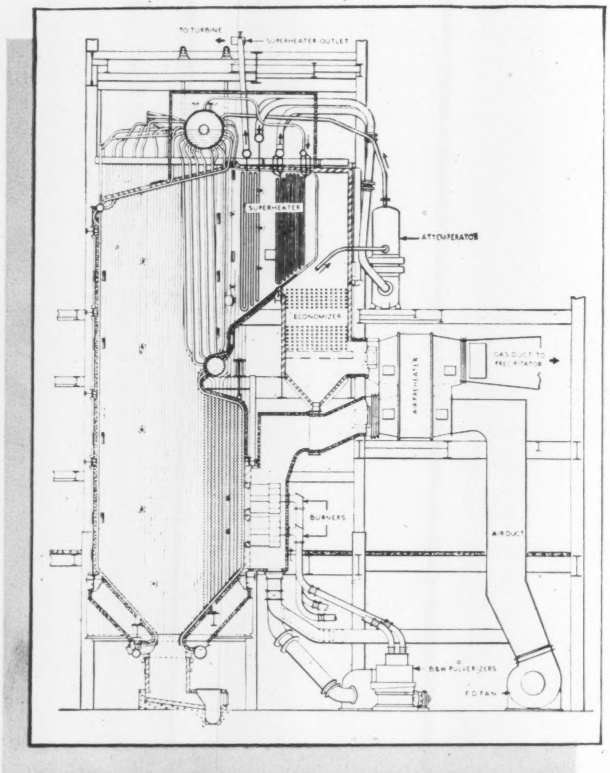
## "*unusually satisfactory*"

A large factor in meeting increased power demands in the 2,300 square miles served by Consolidated Gas Electric Light and Power Company of Baltimore, is its new Riverside Station. Here, two 550,000 lb per hr B&W Radiant Type Boilers serve two 60,000-kw turbine-generators.

Service records of these boilers to date show a high degree of availability—*in one period between annual inspections, the boiler plant was not responsible for a single outage*. And, the design of these boilers resulted in ". . . slag-free operation of these units which is the more remarkable in view of the wide variety of coal which the war made necessary and which includes coal containing ash with an initial deformation temperature as low as 1900 F and as high as 2800 F".

Such service records stem from equipment well matched to its job from the start. Riverside's first B&W boiler went into operation in December 1942; the second in April 1944. Both met or exceeded rated capacities and within two weeks following initial operations were, in the words of the Company's engineers, "just units on the line". Performance of the boilers, in spite of handicaps imposed by war conditions, has fully met expectations. There has been no difficulty in obtaining rated output over prolonged periods. In fact, "operating experience with these steam-generating units is unusually satisfactory," says the Company.

Experience at Riverside is being duplicated by a similar B&W unit at the Westport Station of this Company. Results with these units are not exceptional, but are being repeated by B&W boilers in public utility stations all over the country—reflecting the high standard of performance built into B&W steam-generating equipment for over 60 years.



Arrangement of B&W Radiant Type Boilers No. 1 and 2 at Riverside Station and No. 3 at Westport Station of Consolidated Gas Electric Light and Power Company of Baltimore. Rated capacity of each boiler: 550,000 lb per hr at 900 psi and 915 F at superheater outlet. Units are equipped with B&W superheaters, attemperators, economizers, and burners. Three B&W Type E Pulverizers supply fuel for each boiler.

Thinking and planning for tomorrow *today* is a job that B&W engineers are ready to tackle—in partnership with your engineers—at any time.

**Water-Tube Boilers, for Stationary Power Plants, for Marine Service . . . Water-Cooled Furnaces . . . Superheaters . . . Economizers . . . Air Heaters . . . Pulverized-Coal Equipment . . . Chain-Grate Stokers . . . Oil, Gas and Multifuel Burners . . . Seamless and Welded Tubes and Pipe . . . Refractories . . . Process Equipment.**

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# MECHANICAL ENGINEERING

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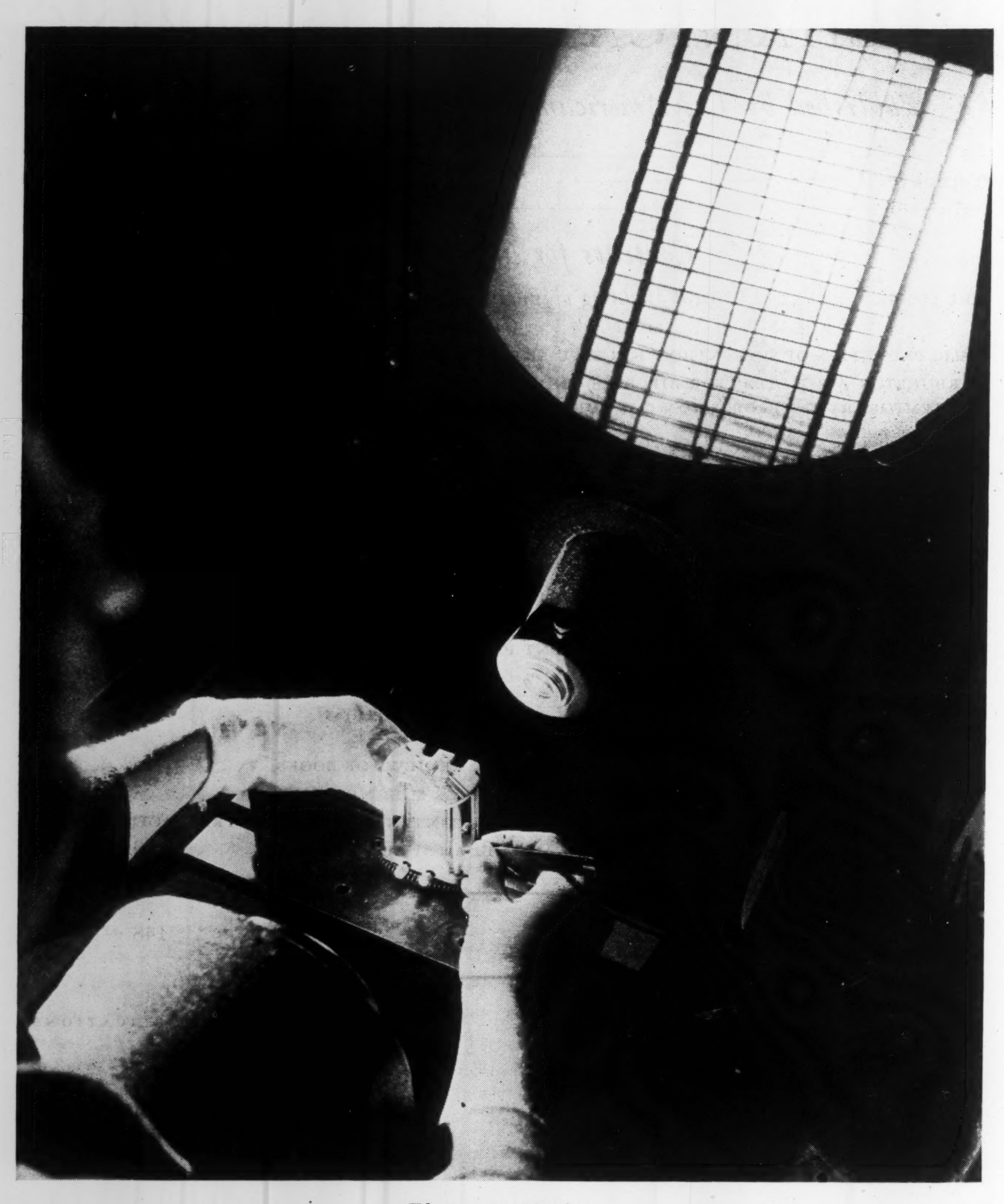

*Electronic Shadow*

*(War-important 813 transmitting tubes must pass the scrutiny of the Shadowgraph's eye at the Dobbs Ferry, N. Y., plant of North American Philips Co., Inc. A powerful light source is projected upon the tube mount. Then, a lens system picks up the shadow-image and throws it on a ground-glass plate. The tube has two grids which must be in perfect alignment laterally—otherwise electronic characteristics are unsatisfactory. When 813's meet this requirement, with one tube element exactly behind the other, no evidence of a second "ladder" can be observed on the 20-to-1 enlargement.)*

MECHANICAL ENGINEERING

Volume 67
No. 11

November
1945

GEORGE A. STETSON, *Editor*

## *A.B.C. Standards Conference*

A RÉSUMÉ of the achievements of the recently concluded Conference on Unification of Engineering Standards held under the auspices of the Combined Production and Resources Board in Ottawa, Canada, will be found on page 776 of this issue. Not included in this résumé is the report of evidences of international co-operation and good will that were by-products of the technical discussions and understandings. These found expression in luncheons and dinners and the addresses on these occasions, in which members of The Engineering Institute of Canada and The American Society of Mechanical Engineers played prominent roles.

On Thursday evening, September 27, the entire group of persons from the United States, Great Britain, and Canada who were in attendance at the Conference were guests of the Hon. C. D. Howe, honorary member E.I.C. and A.S.M.E., Minister of Munitions and Supply and Minister of Reconstruction of the Canadian Government, representative of that government and host of the Conference, at which he presided and presented to the guests Sir William Stanier, Special Adviser to the Ministry of Production and chairman of the Mechanical Industries Committee of the British Standards Institute, and the Hon. Ray Atherton, United States Ambassador to the Dominion of Canada. W. L. Batt was the principal speaker at the dinner.

On the following evening The Engineering Institute of Canada and The American Society of Mechanical Engineers entertained groups from the three participating nations at a dinner at the Rideau Club at which R. M. Gates, past-president A.S.M.E. and C. J. Mackenzie, past-president E.I.C., were co-chairmen. An outstanding feature of the dinner was the presentation to Sir William Stanier of a certificate of honorary membership in A.S.M.E. A sketch of Sir William's career was given by Mr. Howe and the certificate was presented by Mr. Gates.

Attending the Conference were fifteen delegates from Great Britain, who were joined at Ottawa by additional British delegates from Washington, a Canadian representation of about twenty, and more than one hundred from the United States.

The Combined Production and Resources Board is made up of one representative from each of the three countries. W. L. Batt, honorary member E.I.C. and honorary member and past-president A.S.M.E., represents the United States; Sir Henry Self, the United Kingdom; and C. D. Howe, Canada. Sir Henry Self was represented by his deputy, H. G. Vincent. S. J. Harley headed the United Kingdom delegation, H. G. Vincent the Canadian delegation, and E. J. Bryant, member of the A.S.M.E., the United States delegation.

The opening session of the Conference was addressed by Mr. Batt and Mr. Vincent. Mr. Batt appealed to the three countries to capitalize immediately upon the advances which, because of war urgency, had been made already in standardization. In his opinion an effective blow for peace would thereby be struck. After he had referred to the successful engineering of new screw-thread standards during the war and how differences such as simple and rudimentary parts of machines had cost the United States, in the early stages of the war, at least $100,000,000, he concluded by saying:

"Now that the fighting phase of the war has ceased, no doubt some of the pressure for these improvements will vanish. Yet it is clear that if standards in manufacture are of value to all manufacturers within a nation, they are no less valuable—nay, essential—to manufacturers engaged in world commerce.

"I happen to be one of those firmly convinced that economic frictions underlie most of our wars. I am among those who believe that the way to eliminate economic frictions is to facilitate trade, and it is clear to me that different standards of screw threads will always be an obstruction to easier trade. Therefore, I ask all of you to approach this question with something of the spirit of a zealot.

"Engineers must see the unification of standards through to a final conclusion. The governments of our countries must, and I assure you this is important, assist through wholehearted encouragement in the work of this project. All of us have recognized how vital it has been to combined war production. Let us now have uniform standards and thereby strike a blow for peace."

Mr. Vincent said that the primary purpose of his country's first mission to the United States in 1943 was to assist in resolving difficulties which had arisen in the production in America of Whitworth threads for munitions of British design for British Forces, but once started, the scope of the work extended.

"The work," he asserted, "is notable for its future prospects. So much that has been done in C.P.R.B. has been transient, a diversion of resources to war and expedients for war purposes. Most of that has served its purpose. But there is something which should be more lasting. The groups of experts which have been formed under the stress of war will no doubt continue in being. The programs of research will be carried on, with the object of getting optimum values of the relative strengths of threads of different forms. These are systematic practical tests, for the matter is not solely one of compromise or adopting the mean, but of establishing the best thread, sound in performance and simple in manufacture. The strength of the United Nations will be less than it should be, less ready for emergencies, if this work is not pursued."

In conclusion he said, "So we believe that this work will go on, although the present conference is probably the last to be held under the aegis of C.P.R.B. In that latter respect there is no cause for grief. C.P.R.B. was designed for war, to operate in conditions of overriding government control. Essentially progress in engineering standards relies on voluntary co-operation in industry. The standards and rules in each country are the outcome of this co-operation, seeking to advance the application of engineering science and its contribution to human betterment. It is best for those familiar at firsthand with working conditions, whose lives are devoted to the needs of industry, to reconcile the initiative and ingenuity of the designer with the convenience of standardization. . . . C.P.R.B. may take pride in the beginnings of this work, in which representatives of the three countries, expert and lay, have met together in good will and to good purpose."

## *Aid to Science*

As will be noted by reference to the Record, pages 746–757 of this issue, two research organizations have recently announced programs of aid to science and education in the very concrete form of financial grants to young scientists and the colleges.

The National Research Council is receiving nominations and applications for doctoral fellowships in the mathematical, physical, and biological sciences; and the Research Corporation is offering grants to the total of two and one-half million dollars, in addition to its normal grants, to educational institutions in a program designed to permit young scientists, engaged for the most part in war research, to undertake at universities and colleges research of peacetime importance in pure science, especially chemistry, physics, mathematics, and engineering.

Although the N.R.C. grants are made "to help young men and women whose graduate study has been prevented or interrupted by the war, to complete their work for the doctorate" and the Research Corporation grants are made to educational institutions to enable them to attract young scientists to undertake research, both fundamentally serve the same purposes—to repair as quickly as possible the damage done by the war to education and research in science as carried on at the universities, to afford opportunity for young persons to undertake training for careers in science, and to restore to normal the scattered teaching and research staffs upon which progress in science depends.

The teaching of science is costly. It requires personnel, laboratories, and equipment. Those who teach science and engage in scientific research at the universities are tempted by opportunities offered to them in industry and the great research foundations and even government-supported institutions; and while the universities must meet the demand for training men for these nonacademic posts, they must also retain for that purpose and for the enrichment of scientific knowledge and the stimulus of individual achievement those best suited to carry on their work in the atmosphere of the university. Money to compensate for the financially nonproductive years of study for the doctorate and money to attract brilliant young scientists to the teaching and research faculties is an essential without which only indifferent results can be expected. It is for this reason that the NRC and Research Foundation aids are important to the future welfare of our nation. They are significant of a trend of the times from which we shall reap abundantly in the future; for, although only two sets of grants have been singled out for comment because announcement concerning them appear in this issue, numerous individual and corporate donations to the advancement of education and research in science, such as the Rockefeller Foundation, for example, have been made public during the last year.

The university has many important functions, among which education and research in science are of great present-day importance. We live in a civilization based broadly on the results of scientific research. Our tasks and problems are conditioned by what science has accomplished. From the leaders in public and private life down to the humblest citizen no one can escape the effects of the impact of science on his life. It is not only those whose careers lie in the field of science who must increase their understanding of science and its significance. Every educated citizen must be given this opportunity in as great a degree as is possible. The responsibility of our schools and colleges to see that these opportunities are available is great.

Unless enthusiastic encouragement and ample support are given to science and engineering by university administrators, the university will fail in one of its most important duties. It is not enough that enthusiasm and stimulus for support may originate in the faculties of the sciences. The way must be cleared for them and the initiative should be taken by those in charge of policies and finances. Grants by individuals, corporations, and foundations ease the financial burden but they do not lessen the responsibility of the universities for leadership, encouragement, and support of science and scientists.

It is, perhaps, too easy a solution of this financial problem for universities and their administrative officers to hope that needed funds will be appropriated by federal, state, and other governmental authorities for the support of teaching and research. But while the amount of money thus made available to them may ultimately be greater than could be secured from private endowments and grants-in-aid, separation of academic from governmental control, no matter how benignly and intelligently such control might be exercised, should be maintained in privately endowed institutions. These institutions must, therefore, continue to rely upon gifts from individuals, corporations, and foundations. For this reason, among others, the grants of the Research Corporation are important and significant. They do not lessen the responsibility of individuals, regardless of how limited their means may be, to support the privately endowed universities. Rather, they set an example and brighten the prospect that such institutions will grow and prosper and continue to serve the public within the framework of the individual enterprise of free men and establish criteria against which research and teaching carried on under public financing can be evaluated.

# *Basic Principles of* SUPERVISION

## *For Safe and Efficient Production*

By H. W. HEINRICH[1]

THE TRAVELERS INSURANCE COMPANY, HARTFORD, CONN.

A first-line foreman is a much more important figure in industry than is generally believed. In the final analysis, dependence is placed upon him to control the safe and efficient production of goods and services vital to the nation in times of peace or war. Yet, in the great majority of cases, he is untrained in the very art in which he is expected to be proficient. It is unfortunate that this should be so, because there are more than 4,000,000 foremen, leaders, or other first-line supervisors in the industrial and mercantile establishments of the country, and also because lack of training obliges them to learn their basic duties the hard way, i.e., by long and often painful personal experience. The purpose of this paper is to make clear who and what the first-line foreman is, why the success of industry is dependent upon him for the safe and efficient production of goods and services, the critical lack of training for the vital work of supervision, and finally the basic factors of supervision itself as applied to the practical everyday phases of industrial activities.

### MANAGEMENT RELIES ON THE FOREMAN

Management provides capital, does the planning, purchasing and organizing, erects the structures, installs the machines and equipment, and also provides the personnel. This being so, it is evident that neither workman nor supervisor would even have a job except for management. However, management itself does not do the actual work of producing goods and services. Production, efficiency, and safety experts criticize and suggest, but they too do not turn out the work. The individual employees are the real producers but they do not move except under the direction of supervisors. No one is as vitally important in the job of keeping the wheels of industry turning as the foreman.

Typical illustrations by the thousands may be found in any and all kinds of work. One such illustration follows: In this case, a heavy railroad locomotive had been built and prepared for shipment overseas. The actual job at the moment was that of hoisting the locomotive from the dock, carrying it down the dock about fifty yards, swinging it over the water and landing it on a barge which was then to be towed to a waiting cargo ship. Although a tremendous amount of work had been done prior to the job being described, it must be kept in mind that each one of the thousands of tasks that had been done up to the moment when the locomotive was to be hoisted and transferred to the barge, must have been equally susceptible to exactly the same sort of supervisory control as was the particular job that provides the basis of this illustration.

Prior to the moment when the hoisting was to be done, the dock area in the immediate vicinity of the locomotive was a veritable beehive of activity. There was a representative of a foreign government on hand together with representatives of the shop management; the boss rigger was present to look things over, much preparatory work had been done in the way of bringing up and securing the barge, the dock had been cleared of obstructions, the crane had been brought on up, slings had been placed and, of course, the locomotive itself had been built, tested, checked, sealed, and otherwise prepared for overseas shipment. The plant safety director and one of his inspectors were on the job, giving consideration to literally dozens of safety matters, including the possibility of overloading, overhead high-tension wires, clearing the dock of persons and obstructions, consideration of the hazards of a swinging load, slack in the lines anchoring the barge to the dock, provision of guide lines, the position taken by men on the barge below, etc. A tremendous tonnage was involved and likewise the possibility of loss of life and of many thousands of dollars in the event something went wrong during the operation.

As the moment for raising the locomotive approached, the group of persons faded away, leaving no one but the operator of the crane who was sitting in his cab calmly awaiting orders, and the first-line supervisor. The representative of the foreign government, of course, had nothing to say. Representatives of management likewise realized that it would not do to interfere in any way with a competent foreman, at least during the actual performance of his work. The boss rigger naturally left the final action to the foreman. The safety director and his inspector had already made all of their suggestions and recommendations and could do nothing but retire and await results. The operator of the crane merely awaited a signal. In short, so far as the actual performance of this particular job of hoisting was concerned, success or failure lay entirely in the hands of one man.

This man, the first-line supervisor or foreman, made a last-minute check, noting that the crane fall had been properly centered, slings and guidelines properly attached, preparations on the barge completed, men in the clear, and all other conditions and circumstances satisfactory. Although the situation was not at all unusual except perhaps for the huge size, weight, and cost of the object, the circumstances nevertheless were dramatic. The foreman caught the eyes of the crane operator and the two men who were to attach the slings to the hook, raised his arm and gave the customary signal to lower away, and then when the connections had been made signaled to take up the slack while he checked adjustments, saw that persons were in the clear, raised the locomotive a few inches, and then when satisfied signaled to "take it up." The locomotive was then carried down the dock opposite the barge, swung on out over the water and finally lowered and secured on the barge itself.

All this was done smoothly, competently, and safely as the result of the work and the direction of no one else but the first-line supervisor. No one else could have done the job. No one dared to interfere. Notwithstanding the wealth of brains and ability in the entire plant, at this particular moment and for this particular job, dependence had to be placed wholly upon one man. The best that others could do was to hope and pray that all of the prior work that had been done, and that all of the training and instruction, all of the suggestions and recommendations, and all of the thought that had been given to the selection of supervisors would now bear fruit and that this particular job would be carried out safely and satisfactorily by the one man in whose hands lay success or failure.

---

[1] Assistant Superintendent, Engineering and Inspection Division.

Contributed by the Safety Division of the Metropolitan Section, New York, N. Y., of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

### FOUR CARDINAL PRINCIPLES OF SUPERVISION

In the case of any successfully completed individual industrial job, such as the hoisting of a heavy object, the launching of a ship, the welding of plates, and even the commonplace and myriad tasks in machine shops, woodworking plants and thousands of other tasks, the key figure is invariably the first-line foreman, and there must be a complete understanding between him and the workers. There should be no question of failure to act as ordered. If success is achieved, there is no such thing as insubordination. Property is not damaged nor is anyone hurt because someone forgot or was too busy, too late, incompetent, or unskilled. And why does all this work so smoothly? To begin with, the foreman has the proper attitude. He understands and accepts full responsibility. He uses his authority fairly but decisively. He has the ability to get things done. In addition, the foreman has complete knowledge of all aspects of the job that he needs to know about. Finally, he has put his qualifications to work and has actively demonstrated them in dynamic action.

He makes a constant effort to obtain facts; facts as to both probable and existing practices and conditions that affect safe and efficient production. He knows that facts may be stumbling blocks or stepping stones, depending on what they are and how they are arranged and used, so he gets pertinent and useful facts and builds them into a stairway leading directly to the successful control of his job. He has selected workmen who know exactly how to do their particular tasks. Instructions are given explicitly. Care is taken to see that the instructions are understood. Emergencies arising from possible faults of persons and equipment are anticipated and guarded against. Things work out as planned because they are planned and because the basics of supervision are understood and practiced by a qualified foreman. It can be done. It is being done. The chain of supervision links men, machines, and materials with safe and efficient production.

The instances described are given only because they make interesting illustrations and because they are typical of the vitally important work being done by foremen in many lines of industrial effort. Other foremen known as leaders, supervisors, overseers, or by other similar terms are giving orders daily to workmen who are engaged in metalworking, woodworking, the steel and iron, textile, food, chemical, plastics, warehousing, stevedoring, construction, and mining industries, and in a great variety of other industrial operations. These foremen accept the responsibility for seeing to it that the orders which they give are properly carried out. This acceptance of responsibility covers the quality, volume, and cost of production, and the conservation of life and property.

Trite as the expression may be, the foreman is and always will be the "keyman" of industry. He is definitely in the middle. Management authorizes and finances, provides the tools, equipment, and personnel, and then holds the foreman responsible for getting the job properly and safely done. The workmen, on the other hand, while actually doing the job itself, look to the foreman for instructions and guidance. It is a big job. None but a well-qualified person can do it and he needs help. He should not have to learn the hard way—by bitter, long, painful, and costly personal experience. He should be given an opportunity to learn such basics of supervision in the control of production and safety as will assist him in time of peace or war to do the kind of a job that is so vitally needed for the progress and security of the nation.

### FOREMEN DESERVE A "BREAK"

Prospective foremen and those already practicing the art of supervision deserve a "break." The basics of supervision should be expressed for their benefit in simple understandable language. The explanation should be stripped of superfluous material so that the basic factors may the better be emphasized, memorized, and appreciated to the fullest extent. It should be made clear that these factors apply both to safety and production; that unsafe and improper practices of persons and unsafe and improper mechanical conditions are the proximate causes of both production faults and accidental injuries; that the same persons create these faulty conditions, that the same remedies apply, and that the same person (the foreman) has the best opportunity and the responsibility to effect control.

### TRAINING METHODS ARE INADEQUATE

Many of the larger and more progressive industrial concerns provide supervisory training. However, in few instances is this training directed to the subject of supervision as a whole; in other words, to the basics or elements of the entire subject of supervision. Instead it deals with individual phases of the subject without relating these phases to one another and to the fundamentals of supervision in such a way as to permit the foreman to obtain a comprehensive understanding of his profession. Actually, the net result of current training methods is to leave him quite confused, if not, in fact completely bewildered by the magnitude and complexities of his task.

One has but to review the subject matter of existing training courses to realize the truth of this statement. There are excellent training courses in job instruction, job management, and job relations; training courses are provided in safety, grievance control, inventory, time-and-motion study, job analysis, and other individual phases of supervision. These courses should be, but are not, preceded by a course in the basics of over-all supervision itself. If this is not done, the situation is comparable to one where an attempt is made to teach higher mathematics without first having taught elemental arithmetic and algebra. A nationally prominent educator has stated that "the supervisor should first be taught the basics of his profession and then its separate phases."

### BASIC FACTORS IN SUPERVISION

There are sixteen factors in supervision.[2] These constitute a chain linking men, machines, and materials with safe, efficient production. It is well to keep in mind too not only that the conditions and circumstances creating production loss and injury are alike but also the methods of control for both production loss and injury are similar, and that the sixteen basic factors of supervision apply both to production and safety.

The sixteen factors fall logically and naturally into four major groups, namely, "attitude," "ability," "knowledge," and "action," of which the last is the dynamic expression of the first three.

Under "attitude" are factors relating to the willingness to lead, the recognition of responsibility to top management and to employees, and the sense of balance and fair play. It may be said with regard to a foreman's attitude that "he should feel right and think right about his workmen, his employer, and his job." But proper attitude alone does not make a good foreman. He must have the "ability" to display that attitude, as indicated by the person who is perfectly willing to lead but has no idea of how to convince or command and thus fails to obtain the respect of his group and their maximum in safe and efficient production.

It is clear also that a proper attitude, even when supplemented by ability, still is insufficient to get supervisory results. To these factors must be added "knowledge," both of the job and of the workmen as well.

---

[2] "Basics of Supervision," by H. W. Heinrich, Alfred M. Bost & Co., New York, N. Y.

A practicing foundry foreman may have the proper attitude and may also have the ability to get results in a foundry, but he may be a total failure in a tannery until he learns something about hides, tanning, fleshing and dehairing machines, skivers, and glazing bucks. Therefore, knowledge of men, machines, processes, etc., is an important third group of supervisory factors.

Even these three groups, "attitude," "ability," and "knowledge," do not cover the ground completely. A foreman who has the right attitude and ability, knows about the workmen and the job as well, must put these characteristics to work, or remain merely a well-qualified nonperformer.

Thus emphasis gravitates to the four basic factors under "action," these being: Training and instruction, giving orders, checking compliance, prevention and correction.

Briefly, it can be said that the four factors under "action" cover broadly the entire field of effort in any kind of industrial supervisory work. Each one has four specific subdivisions. They are mutually exclusive or nonoverlapping. Even though a foreman is not expected to teach or instruct workers in formal classroom fashion, he nevertheless does do a certain amount of training and instructing as a part of his daily work. This is not the same thing as "giving orders," nor are the required abilities and knowledge the same. Giving orders is an art in itself.

When employees have been properly trained and instructed and have also been given the necessary orders, it follows that they and their work must be checked for compliance with orders. This, too, is something that requires skill and understanding on the part of the foreman.

Finally, when despite the best of training and instruction and the correct orders, the foreman finds, as a result of checking for compliance, that errors or faults have occurred, he then must take action in the way of prevention and correction. This sixteenth, final, and most important basic factor in the entire supervision chain deserves amplification.

Prevention and correction, as applied to unsafe and improper actions and conditions and as relating both to safety and production, consists of four kinds of supervisory action. These fall in groups headed by "engineering revision," "persuasion and appeal," "personnel adjustment," and "discipline."

### FOUR METHODS OF PREVENTION AND CORRECTION

*Engineering Revision.* This form of remedy is defined as the work of changing, relocating, eliminating, guarding, substituting one thing for another, etc. It applies to all safety and production problems involving unsafe or improper mechanical or physical conditions where it is practicable to improve or revise such conditions.

Engineering revision often is a remedy for problems arising out of unsafe and improper practices of persons when these practices are committeed because it is difficult, impossible, awkward, uncomfortable, inconvenient, embarrassing, etc., for the person to perform safely and properly. The method also applies when the unsafe and improper practice is so attractive, enticing, convenient, etc., as to make it preferable.

*Persuasion and Appeal.* This form of remedy is defined as the work of giving specific information of a helpful nature, of instructing and persuading, or of appealing to the motivating characteristics of persons in an effort to prevent repetition of unsafe and improper practice and to encourage safe and proper practice.

It applies when persons commit unsafe and improper practices because they are not informed or not skillfull with regard to safe and proper practice, or are not convinced that their performance actually is improper or unsafe, and for other related reasons.

In general it may be applied to any case of improper or unsafe personal practice, regardless of the reasons therefor, except instances where personnel adjustment and discipline are required. Instruction may also be coupled with giving orders and applied to the prevention and correction of unsafe or improper mechanical conditions.

*Personnel Adjustment.* This form of remedy is defined broadly as including action made necessary when workers are not physically or mentally suited to the work that they have to do. The foreman, not being qualified to practice in any one of the fields of medicine, is required merely to accept his responsisibility for noting, as best he can, evidence of abnormalities, and for seeing to it that the persons in question are directed to authorized practitioners.

The remedy applies when a person, because his physical or mental health is impaired, commits or appears in danger of committing unsafe and improper practices and as a result is unsuited to his work. It applies also to cases where there is no evidence of abnormality or impairment, but where persons are not suited to their work because of height, weight, grievance (real or fancied), age, attitude, idiosyncrasy, aptitude, etc.

*Discipline.* This form of remedy is defined as persuasive or penalty methods of enforcing rules. It applies when unsafe and improper practices are committed because the person's attitude is improper and then only as a last resort when other methods fail.

The foreman should exercise the greatest of discretion and caution when considering any form of action of a disciplinary nature designed to correct the attitude or performance of a workman and, if and when discipline is required, should apply it strictly in accordance with established rules of company policy.

First of all, he should appreciate that the resort to discipline is an admission of failure on his part. It means that he has been unable to find a remedy in the vast field of engineering revision. He has been unable to guard, change, relocate, or otherwise revise, alter, or improve the mechanical phase of the person's job so as to make it reasonably foolproof. Furthermore, he has been utterly unable to persuade or convince the workman to reform. He has failed, too, in his methods of appeal. He can see no way out, as a result of considering assignment of other work, a change of environment, or sources of ill health, worry, and fatigue.

To be sure, there are some cases where discipline applies, but even when these occur, the foreman would do well to remember that there are several forms of discipline such as admonition and loss of privileges, and that monetary or employment penalties are the least fruitful of all.

### ON-THE-JOB SUPERVISION

The correctness of placing emphasis on the dynamic part of the foreman's work, as indicated by the four factors under the group heading "action," may readily be proved by unbiased consideration of the performance of a foreman when on the "firing line" of an establishment that has been in operation for several years. Ordinarily, he and his crew come on the job together at the start of the day or shift. They begin where they left off or where the previous shift left off. The foreman already knows that the work to be done is a continuation of what has been done before. He checks the workmen to see that all are present and immediately is plunged into dynamic action. Two of the workmen are absent. The work must go on because the plant will shortly be awaiting completion of the job.

His action is direct and simple. First he issues the necessary orders for the workmen who are on the job and sees to it that they, as well as the tools, equipment, etc., are functioning as usual. Then he reports to his superintendent, asks for the assignment of at least one additional trained man on a temporary basis and let's say his request is granted.

When the newly assigned worker appears, the foreman makes a rough check of his ability and knowledge of the

(*Continued on page 714*)

# CARBURETOR AIR FILTERS *for* AIRCRAFT ENGINES

By RICHARD S. FARR

FARR COMPANY, LOS ANGELES, CALIF.

AIR filters of one kind or another have been used on small planes for a number of years. It was, however, only with the outbreak of the war that the problem of filtering air on large aircraft was encountered. Prior to the war, large aircraft were always operated from surfaced fields and flown when conditions were favorable. This, of course, was not true in the case of small individually owned planes that were operated in many cases from dirt fields where dust conditions were caused by other aircraft taking off and to wind. With the wartime necessity of operating military aircraft from temporary fields, taking off under all conditions emphasized the need of removing dust from the carburetor air. Severe dust conditions were encountered in taking off from nonsurfaced fields in high winds, or in group take-offs.

### FILTER PROBLEM CREATED BY DUST CONDITIONS

It has been stated many times that in group take-offs from nonsurfaced fields the airplanes following the first off the field encountered such heavy dust that it was frequently necessary to take off by instrument in the middle of the day. These excessive dust conditions caused unusually heavy wear on the engines, with the result that the life of some of these aircraft engines was as low as 18 to 25 hours. After this period of operation, the oil consumption of these engines rendered them useless from a military standpoint. This meant a major overhaul or exchanging the engine, which at that time was difficult to do because of the shortage of aircraft engines and adequate help and parts to make the repair or exchange.

While the critical need for filters was realized at some of the training fields in this country with the expansion of the Air Corps training program, it was not until aircraft were operating in North Africa that a real drive was started for carburetor-air filtration. The first attempt at filtering carburetor air was to install filters in existing designs. This presented a difficult problem, inasmuch as there was not sufficient space for proper filter installation. Some of the early installations, often made in the field, were such that the filter area was too small for the amount of air to be handled. The resulting pressure drop through the filter was so high that the aircraft would not develop its full power. In some early attempts the loss was so great as to prevent take-off.

The next step toward improving filter installations was to alter air scoops to provide for filters. This resulted in a large, bulky scoop that was not very efficient. However, filter velocities were lowered by this addition of new scoops to a point where much more satisfactory operation was obtained. It was gratifying to note that installing the filters in this manner on existing aircraft lengthened the life of the engine from 25 hours to 200 to 400 hours. This method of installing filters took care of the existing aircraft designs out in the field and gave the aircraft engineers an opportunity to redesign their air-intake systems for the various airplane types, improving the filter installation to approach maximum filter efficiency with minimum pressure loss.

It was interesting to note on some of the early filter installations that even though the filter had relatively high pressure loss, the over-all loss on the induction system with the filter was often lower than without the filter. This was due to poor original duct design, the filter acting as a straightener, and the loss through the filter being recovered by better flow through the remainder of the duct system. The problem eventually resolved itself into the installation of air filters in a duct where the maximum duct velocity was 6000 to 9000 fpm, and where the apparent velocity at the face of the filter was limited to 1000 fpm. This filter velocity of 1000 fpm has been increased by new filter designs and by reducing dust concentration in induction air by the use of nonramming air intakes.

### RAM-AIR-TYPE INSTALLATION

The first installations made by the airframe manufacturer were of the so-called ram-air type. This installation is one in which the filter is in the ramming-air intake, and all air must go through the filter except when the engine is operating on hot air. In this installation, pressure loss through the filter is extremely critical, inasmuch as the filter is always in the system, and any pressure loss through the filter is reflected in a reduced manifold pressure, which has the effect of lowering the ceiling of the airplane. On this type of filter installation the Army Air Forces set for specification test a maximum pressure loss of 4 in. of water after the filter had been subjected to the specified dust-loading cycle. This pressure loss of 4 in. of water was based on air entering and leaving the filter perpendicular to the filter face.

The tests set up for evaluating air filters required very large dust-holding capacities and resulted more in endurance than in efficiency evaluation. For selecting the dust concentration to be used in these tests, field experiments were made behind airplanes on dirt fields to determine dust concentration during take-off. These dust concentrations were found to be approximately 0.03 g of dirt per cu ft of air. The particle size of this dirt ranged from —5 microns up to 8 and 10 mesh. Minimum space and pressure-drop requirements, combined with this high dust concentration, made designing for large dust-holding capacity extremely difficult. The result was that, while the filter was required to have a high efficiency and a large dust-holding capacity, available space was such that filter velocity was high with resulting limited filter area and dirt-holding capacity.

Filter-evaluation tests of the Army Air Forces have shown that oil-wet filters are most practical for this application. On an oil-wet filter the dust-holding capacity of the filter is directly proportional to the oil-holding capacity of the filter. The oil-holding capacity is a function of the velocity through the filter, as a result of the wiping action of the air, and the total filter media surface. By taking these factors into consideration, filter design has been improved to such a point that velocities of 1000 fpm and more are allowable with a filter still passing minimum efficiency tests and maximum pressure-drop limitations.

### NONRAMMING AIR-FILTER INTAKE ADOPTED

In use, filters were usually cleaned after each flight to insure

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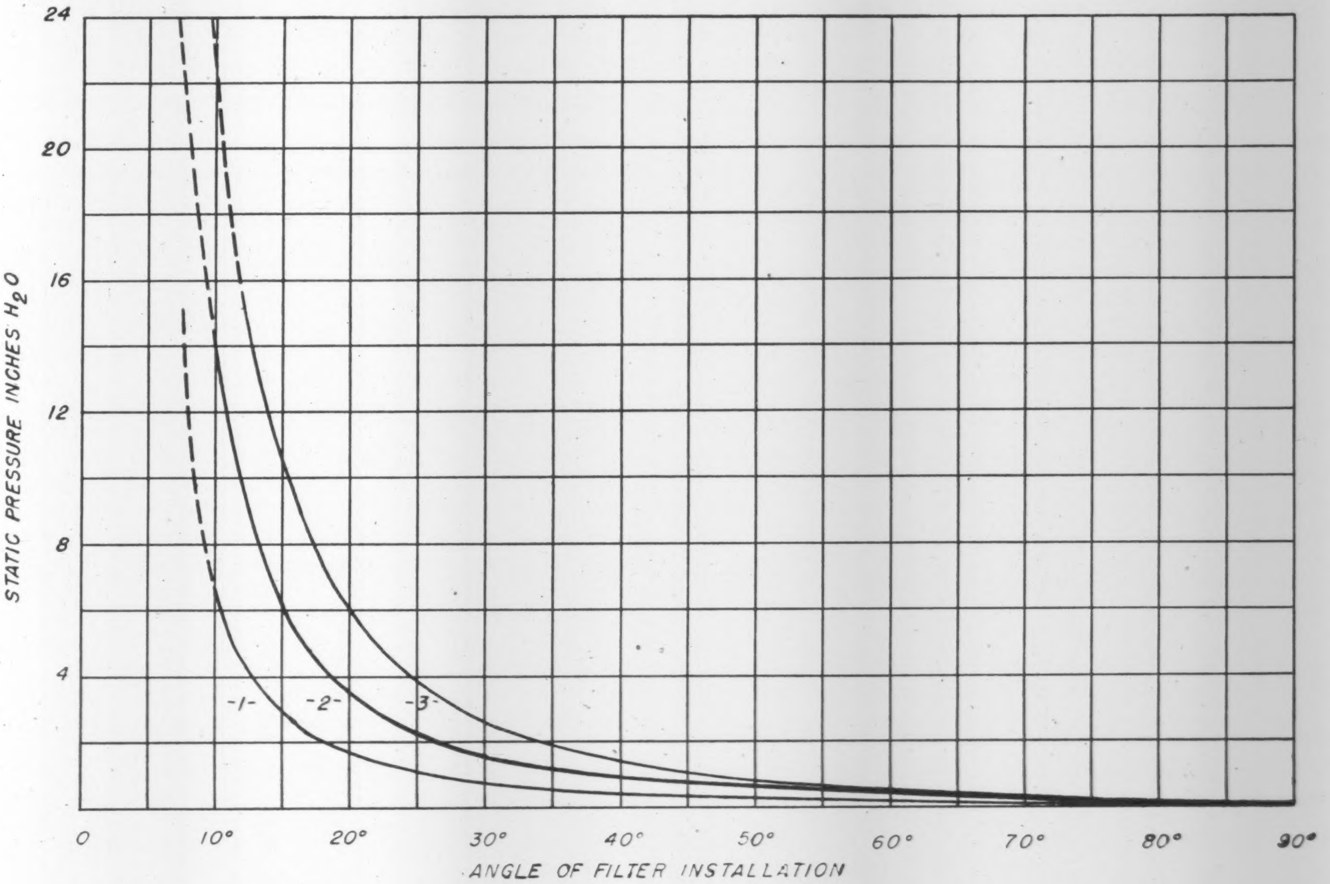

FIG. 1 EFFECT OF FILTER ANGLE

(For total pressure loss add to value from graph pressure loss of filter with 90 deg air flow. Filter-face velocity, 1 = 1000 fpm, 2 = 1500 fpm, 3 = 2000 fpm.)

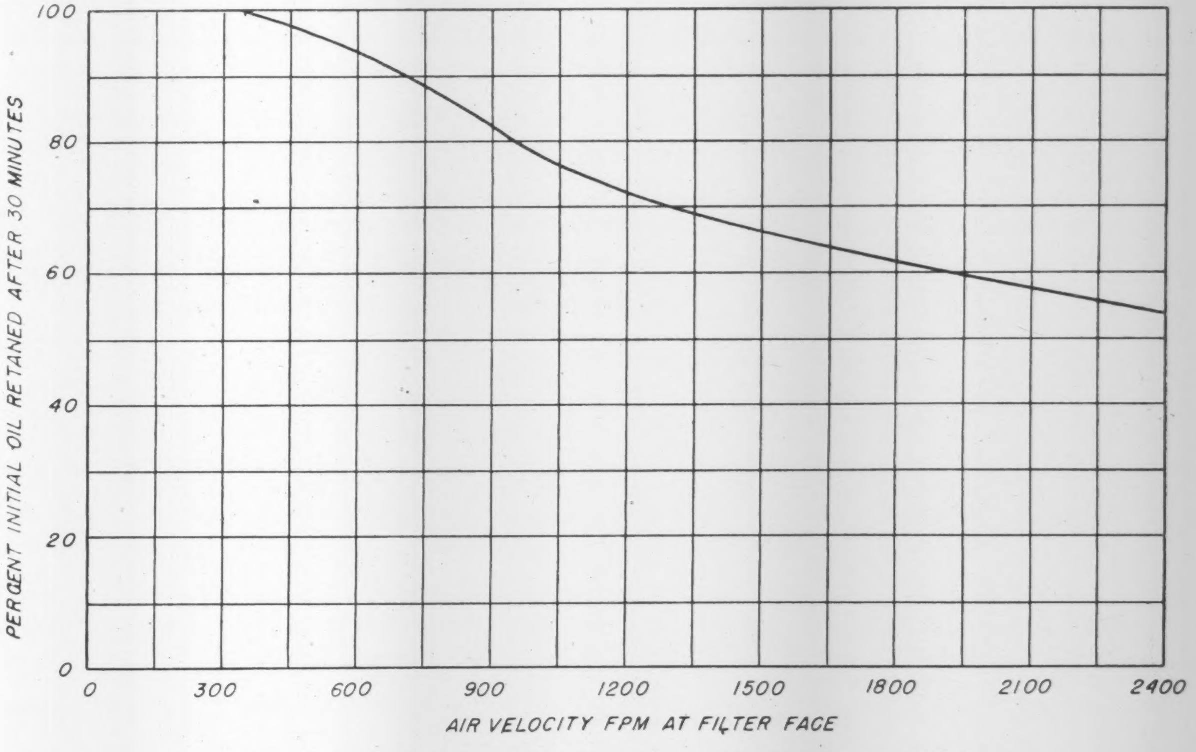

FIG. 2 OIL-RETENTION CHARACTERISTICS OF AIRCRAFT CARBURETOR AIR FILTERS

(Filter dipped in AN-VV-O-446 grade 1120 and drained for 17 to 20 hours at 70 F.)

adequate protection for the engine in abnormally heavy dust conditions. Ramming-air filters were always in the induction system, and the pressure loss through the filter plus the additional pressure loss due to the installation of the filter (that is, the additional pressure loss caused by installing a filter at an angle to the air flow) added up to a sufficient amount at high altitudes to affect materially the performance of the airplane. This fact, together with the desirability of decreasing the dust concentration at which the filter must operate, led to the adoption of the so-called nonramming air-filter intake.

This intake provides an alternate source of air for filtered air in addition to the ramming-air intake. With this system the use of filters is optional with the pilot. The term "nonram intake" was used, inasmuch as the intake for the filtered air was always set at an angle greater than 90 deg to the slip stream. In using an intake such as this, any dirt that entered the air stream and consequently reached the filter had to make a change in direction, with the result that a good portion of the dust was buffed off by use of this intake. Almost all of the coarse dust passed directly by the intake, and only the very fine dust could make a turn and enter the duct to the filter. This allowed a reduction in dust concentration for specification testing filters to 0.01 gram per cu ft of air, and latterly to 0.0075 gram per cu ft of air.

With the reduction in dust concentration, filter velocities increased, for at this lower dust concentration a satisfactory job could be done with less filter media. Filter velocities with nonram intakes have increased up to as high as 2000 fpm. The change from ram air to nonram air, in which system the filter could be removed from the induction system by pilot control, allowed the pressure-drop limitations of the filter to be raised from 4 in. of water to 8 in., the idea being that, since the pilot could cut the filters out at high altitude, a little greater sacrifice could be made for take-off conditions in order to gain smaller filters for higher velocities.

### TESTS MADE ON NONRAM AIR FILTERS

Test work has shown that the pressure loss through the filter when operated at 90 deg to the air flow is relatively unimportant in these low ranges. The most critical pressure loss through the filter is that resulting from the angle of filter installation. This is illustrated in Fig. 1, which shows the rapid increase of pressure loss through the filter as the angle between the filter and the air flow becomes less than 20 deg. Owing to the fact that duct velocities on aircraft are high because of space limitations, the filter must always be installed at a relatively small angle to the axis of the duct in order to provide sufficient filter area. For a given duct size, an increase in filter velocity improves the angle of installation but frequently increases the total pressure drop of the system since, at higher velocities, the additional loss resulting from the angle of filter installation is greater. Consequently, a careful study of the allowable space must be made in selecting a filter velocity in order to get the lowest possible filter pressure loss and maximum operating engine efficiency. Furthermore, a low pressure loss through the filter allows filter seals to be more effective.

Another factor which must be considered in selecting filter velocity is that the amount of oil blown off the filter is a function of filter velocity. Oil in the duct after the filter is not desirable, as it may affect carburetion by fouling jets and Venturi section and may also foul spark plugs. Special tests, designed to determine oil retention of aircraft-carburetor air filters after dipping in oil and draining for 15 to 20 hr at room temperature, showed the amount of oil blown off the filter at 1000 fpm to be approximately 22 per cent; at 1500 fpm, 34 per cent; and at 2000 fpm, 42 per cent. The amount of oil held by the filter at the end of the draining period was taken as 100 per cent in the tests, Fig. 2. Consequently, with lower pressure losses, less blowoff, and a relatively greater dust-holding capacity to be gained, it is desirable wherever possible to use the lower velocities, referring to lower velocities in terms of 1000 fpm.

### DESIGN AND MANUFACTURING PROBLEMS ENCOUNTERED

When the filter industry was called upon to make filters to meet these conditions, a difficult problem of design and development was presented. In the past, filters had always been operated at much lower velocities with lower dust-holding capacities than were required for aircraft application. The problem was severe also from a standpoint of having the filter light in weight, strong enough to withstand frequent handling and servicing, with the media reinforced so as to resist normal backfire pressures and at the same time, having a sufficient amount of media to hold enough oil for the required dust-holding capacity. The result of this has been an improvement in frame construction for lightweight and strength together with improvements in media design and stiffening of the media.

One of the biggest weight-saving developments on the filter was the use of aluminum for media and aluminum for frames. Some of the first attempts at aluminum frames were not too satisfactory, as they were made from soft weldable alloys, but later these frames were developed in 24S-T Alclad, which service reports have shown to be satisfactory.

For a while the Army Air Forces specified that all filters be rectangular in shape, with a fixed thickness of 2 in. This was an attempt to achieve some degree of standardization in filter design and at the same time provide a filter which could easily be sealed against air leakage. Recently this limitation has been removed, with the result that special filter shapes are being made to fit the individual design. Inasmuch as each airplane has a particular size filter to fit its own space limitations, the advantage of standardizing on rectangular shapes was minimized. Some of the present-day installations are curved to fit fuselage shapes, are trapezoidal for space requirements, or involve other odd shapes in order to utilize fully the available space.

### CONCLUSIONS

In summing up the desirable features of aircraft filters, they should be light in weight, durable in construction, high in efficiency, low in pressure loss, easily cleaned, and operated at velocities which cause the minimum of oil entrainment. There is plenty of room for development of filters and nonram intakes. Postwar times will see most small planes equipped with filters, but the demand for filters on large planes remains a question, inasmuch as engine life on commercially operated planes is good. Whether or not the filter can pay for itself by adding to this life remains to be seen when it is tried in commercial operation. Certainly, it can be said that the air filter has played an important part in lengthening the life of aircraft engines in wartime operation.

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THE Westinghouse Electric Corporation has announced that during the war a "wakeless" torpedo was developed and built for the U. S. Navy, the first electrically propelled projectiles of their type. It is said that these torpedoes, which do not leave the tell-tale wake of bubbles of the compressed-air-driven torpedoes, sank 1,852,200 tons of Japanese shipping, including a 42,500-ton battleship. A special motor, weighing only a few pounds per horsepower, and a high-capacity battery developed by the Electric Storage Battery Company, solved the power problem. Because solder normally used melted under the intense heat of the high-speed motor in its enclosure an improved way to bind the armature coils to the armature was developed.

# *Contemporary* JET-PROPULSION GAS TURBINES *for* AIRCRAFT

By D. F. WARNER[1] and E. L. AUYER[2]

GENERAL ELECTRIC COMPANY, LYNN, MASS.

AMERICAN activity in the development of gas turbines was accelerated greatly when, in the late summer of 1941, the United States Army Air Forces engaged the authors' company to design and build an American version of the British "Whittle" engine.

It was characteristic of our Air Forces that they embarked upon this venture at a time when but 11 hr was the sum total of all flying experience with the Whittle jet-propulsion engine. But to our Air Forces the demonstration they had seen in England was the mark of a new era, and they saw the vital need of it in the war then about to envelop our nation too. With the profound conviction that it was a military necessity, both the Air Forces and the authors' company engaged wholeheartedly in the effort.

It was told in releases to the public in January, 1945, that the first American unit ran successfully on test 6 months after receipt of information. Improvements were made before and since that time and improvements continue to be made. Today, only 3 years from the start of our endeavors, a unit of the same frame size as the original unit develops 50 per cent greater thrust, has improved economy, and many times the life of the original units. In addition, power plants of other frame sizes have been built and are undergoing a similar accelerated development program. Progress on all points continues.

In the interest of brevity, the history of the development will not be repeated here. Such releases made to the public have covered that item very well. A late public release has disclosed the fact that the unit burns kerosene, but the fuel is not necessarily confined to kerosene. Gasoline may be used when all its characteristics are taken into account in design. The change affects principally accessories and minor but important small parts.

### NEW HORIZONS FOR AIRCRAFT DEVELOPMENT

The advent of the jet-propulsion gas turbine has opened up a new horizon to the progressive aircraft designer. With it the problem of designing and constructing an aircraft of high performance and moderate endurance is greatly simplified. Inherently the weight of the jet-propulsion power plant is low, less than one half that of an equivalent conventional engine when all its appurtenances such as propeller, oil tanks, oil coolers, superchargers, air coolers, governors, carburetors, mixture controls, inlet ducts and intercooler ducts, etc., are also taken into account. There are other contributory savings, such as reduced weight of landing gear, now smaller with the jet-propulsion power plant because the ship can be suspended at a low level since the swing and ground clearance of a propeller may be ignored.

The inherent lack of vibration in this type of power plant makes for pilot comfort. Vibration in the plane is so low that the expedient has been resorted to of placing the instrument panel on rubber mountings and of using a magnetic rattler to provide the vibration in the panel to which flight instruments have been usually accustomed. This reduces the errors in the instruments. Aside from the jet itself, noise is largely eliminated, and, since the ships are fast, the noise heard by an oncoming jet plane is insignificant, so that little warning is given by the plane in its approach.

To the aircraft designer, there are now new conceptions of the possibilities in "cleanliness" in aircraft design. The highest performance demands a degree of cleanliness not possible in conventional aircraft embodying conventional engines. These gains have already been realized but cannot be discussed further here.

As conventional engines have been pushed toward higher and higher levels of performance they have become increasingly complex and, it is thought not unfair to state, increasingly temperamental. The array of instruments on the panel of a conventional pursuit ship is an indication of the number of extraneous duties a combat pilot's operations must involve. He cannot possibly do justice to his engine while the enemy is engaging his attention. The converse is also true that the pilot would do a better job on the enemy if, actively or subconsciously, he had less "housework" to do. One control and a fraction of the instruments should make the pilot a better fighter. The jet-propulsion power plant reduces the gadgets to a minimum. With this apparatus, four or five engine instruments only are needed, including (*a*) tachometer, (*b*) gas temperature, (*c*) bearing oil pressure, (*d*) fuel pressure indicator, and possibly, (*e*) bearing temperature.

It is not permitted yet to reveal details of actual performance, specifications, or construction, nor may the number built or contemplated be indicated. This paper is therefore limited in scope, but not so seriously as to prevent a disclosure of the trends and characteristics which would interest the engineer intent upon a study of the jet-propulsion power plant and its operating conditions when based on factors which it will be his privilege to assume.

### FUNDAMENTALS OF JET-PROPULSION POWER PLANT

Generally this paper confines its material strictly to the power plant, introducing the airplane only in so far as ram conditions and plane velocity affect the performance of the power plant. Care has been taken in all the curves not to disclose the performance of actual power plants. The curves shown are, however, based on assumptions which are attainable and practicable today. The curves, the analysis, formulas, the derivations are all included to show the basic character of this form of plant. Enough detail is given to allow those who wish to do so to analyze fully the effects under any conditions of pressure ratio, temperature, and plane speed the investigator wishes to consider. In the interest of secrecy, values of thrust are given in terms of percentage of that obtained on the assumed power plant at full speed under standard air-inlet conditions at sea level and static (no ram).

In Fig. 1 is illustrated a hypothetical jet-propulsion power plant. It is high-speed apparatus, involving care in design, in materials selection, control, and in manufacture to obtain the optimum in performance, economy, and life. Such a power plant would weigh somewhat less than a $^1/_2$ lb per lb of thrust established at full rating at sea-level static. The illustration is

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[1] Assistant Designing Engineer. Mem. A.S.M.E.

[2] Engineer.

Contributed by the Aviation Division and presented at a meeting of the Washington Section, Washington, D. C., Nov. 15, 1944, of The American Society of Mechanical Engineers.

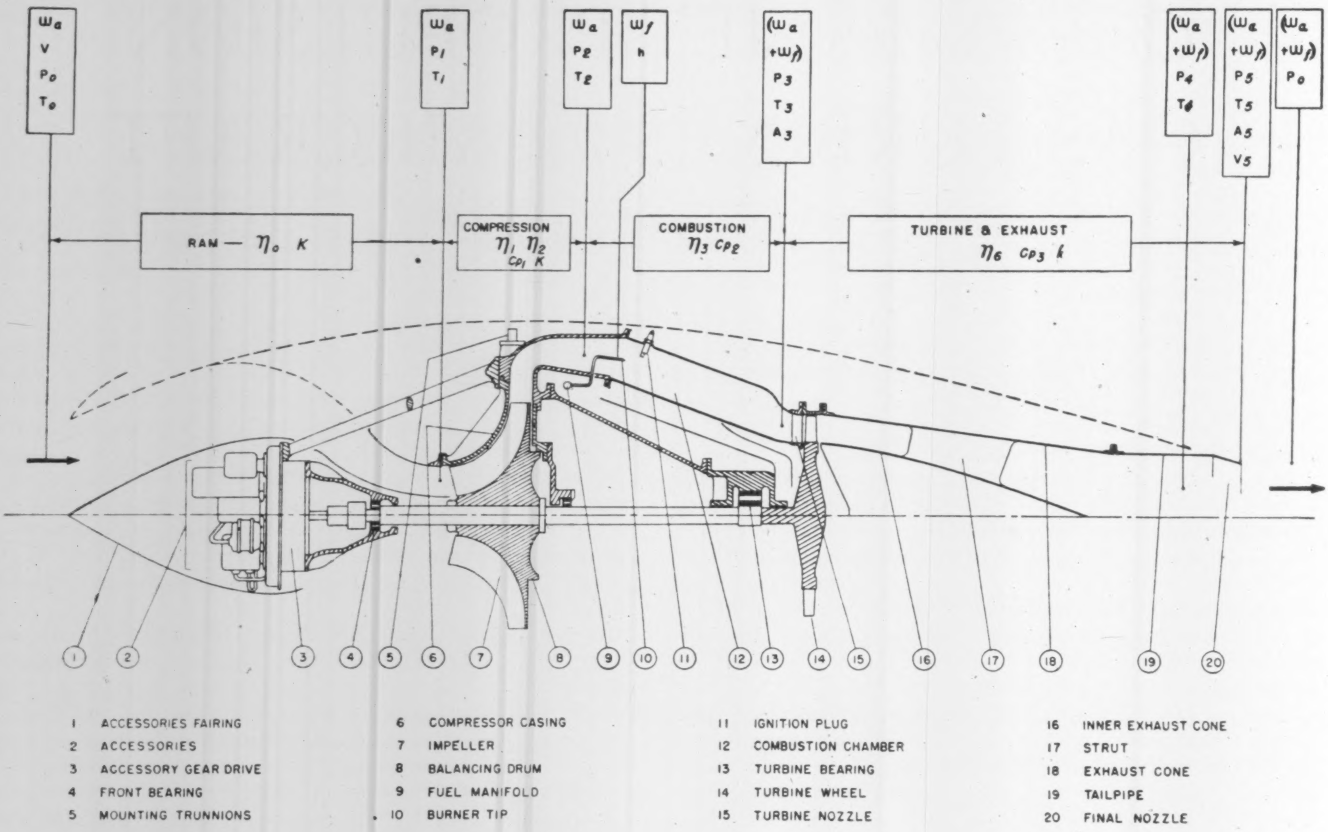
ωa V Po To
ωa P1 T1
ωa P2 T2
ωf h
(ωa +ωf) P3 T3 A3
(ωa +ωf) P4 T4
(ωa +ωf) P5 T5 A5 V5
(ωa +ωf) Po
RAM — η0 K
COMPRESSION η1 η2 cp1 K
COMBUSTION η3 cp2
TURBINE & EXHAUST η6 cp3 k
1 ACCESSORIES FAIRING
2 ACCESSORIES
3 ACCESSORY GEAR DRIVE
4 FRONT BEARING
5 MOUNTING TRUNNIONS
6 COMPRESSOR CASING
7 IMPELLER
8 BALANCING DRUM
9 FUEL MANIFOLD
10 BURNER TIP
11 IGNITION PLUG
12 COMBUSTION CHAMBER
13 TURBINE BEARING
14 TURBINE WHEEL
15 TURBINE NOZZLE
16 INNER EXHAUST CONE
17 STRUT
18 EXHAUST CONE
19 TAILPIPE
20 FINAL NOZZLE

FIG. 1 HYPOTHETICAL JET-PROPULSION POWER PLANT

diagrammatic. In so far as the usage of material in this paper is concerned, the compressor may be centrifugal, of one or more stages, or based on axial-flow principles. The combustion system may be annular or multiple, the turbine may be of one stage, or of velocity- or pressure-compounded stages.

The unit operates on the Brayton cycle. Fig. 2 shows the Brayton cycle on a P-V diagram. Points 0-1-2 establish the compression curve; 2-3 indicates the heat added at "constant pressure." Pressure loss in combustion chambers is also indicated as droop between 2 and 3. Curve 3-4-5-6 is the expansion line to ambient pressure. Point O represents the condition of ambient air at rest.

Point 1 indicates the condition of this air at the inlet to the impeller after it has entered the ram inlet and has been diffused with some efficiency to reduce its velocity substantially to zero relative to the plane. Point 2 represents the condition at the discharge of the compressor. Point 3 represents the condition at the inlet to the turbine. Point 4 represents the condition after expansion through the turbine. Point 5 represents the condition at the nozzle throat. Points 5 and 6 tend to combine at 6 as velocities at the final jet nozzle reduce from supersonic to sonic, and they are one and the same point at all subsonic exit-velocity conditions. The cycle will be further clarified by reference to details disclosed in the Appendix.

If we assume a number of designs of units for various temperatures at turbine inlet, say, 1800, 1600, 1400, 1200 F, and for pressure ratios across the compressor ranging from 2 to 8, all designs based on efficiencies of compression, combustion, and expansion that are attainable and practicable at this state of the art, we can establish the curves as indicated in Fig. 3. The results of increasing temperature and increasing pressure ratio are evident. Practical considerations as to what a turbine bucket or blade will safely withstand and similar conditions in regard to the compressor, to obtain the maximum pressure ratio consistent with efficiency, simplicity, safety, and other considerations, will guide the designer as to the proper choice of the fundamentals to be incorporated in his theoretical unit at this time. Tomorrow's materials or future advancements will trend toward selection of higher temperatures and higher pressure ratios. Weight is a consideration to be accounted for in parallel with economy.

An efficiency of the jet-propulsion power plant of 26 per cent can be realized today at 50,000 ft at 500 mph, Fig. 4. The propulsive efficiency of the jet is of the order of 50 per cent under the same conditions. The combined or over-all efficiency of the power plant and jet in flight is then 13 per cent. In Fig. 4 it will be noted that power-plant efficiency tends to increase at increasing altitude and with increasing plane speed. The improvement attributable to altitude results from decreasing temperature (N.A.C.A. corresponding temperatures are used as a basis of calculation). The improvement from the airplane speed factor is caused by increase in ram pressure ratio with increasing aircraft speed. Propulsive efficiency tends to decrease with increasing altitude due to the relation of jet velocity and airplane speed. Relatively increased jet velocity, which is obtained at high altitudes and lowered temperatures, tends to decrease propulsive efficiency.

The basis of these curves will be demonstrated. (In using these formulas it must be remembered that $\omega_a$, $\omega_f$, $V_6$ are dependent variables and must not be assumed but calculated to satisfy the condition of operation which is assumed.)

### OVER-ALL POWER-PLANT EFFICIENCY PERFORMANCE

The over-all efficiency performance of the jet-propulsion unit and plane may be expressed in terms of the plane speed $V$, the propulsion-jet velocity $V_6$, the weight flow of air $\omega_a$, and the energy input of the fuel $h\omega_f$. The weight flow of fuel added to the air is neglected, and $V_6$ is an equivalent velocity if the jet nozzle is a nonexpanding nozzle operating at a supersonic pressure ratio.

The jet, or gross, thrust is

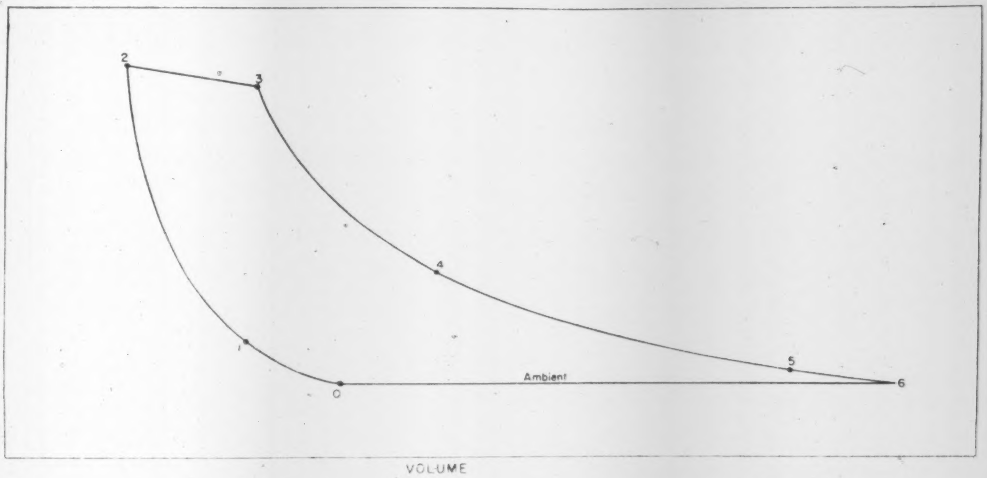

FIG. 2 BRAYTON CYCLE UPON WHICH JET-PROPULSION UNIT OPERATES

$$F_5 = \frac{\omega_a V_6}{g} = \frac{\omega_a V_5}{g} + 144\ A_5\,(P_5 - P_0)$$

The ram drag is

$$F_0 = \frac{\omega_a V}{g}$$

The net thrust is

$$F = \frac{\omega_a}{g}\,(V_6 - V)$$

The power input to the plane is

$$E_p = \frac{\omega_a}{g}\,(V_6 - V)V$$

The power input to the air passing through the unit is

$$E_a = \frac{\omega_a}{2g}\,(V_6^{\,2} - V^2)$$

The power input of the fuel is

$$E_f = Jh\omega_f$$

The propulsive efficiency is defined as

$$\eta_p = \frac{E_p}{E_a} = \frac{2V\,(V_6 - V)}{(V_6^{\,2} - V^2)}$$

The gas-turbine efficiency (complete unit) is

$$\eta_g = \frac{E_a}{E_f} = \frac{\omega_a}{\omega_f}\,\frac{(V_6^{\,2} - V^2)}{2gJh}$$

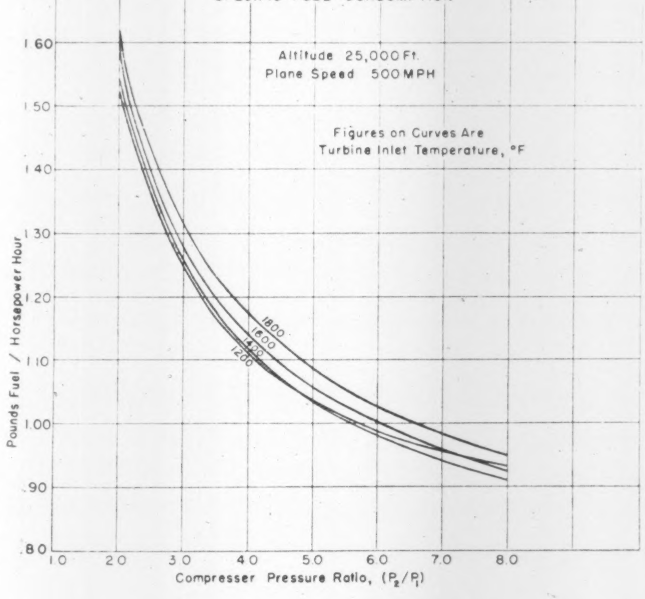

FIG. 3 SPECIFIC FUEL CONSUMPTION

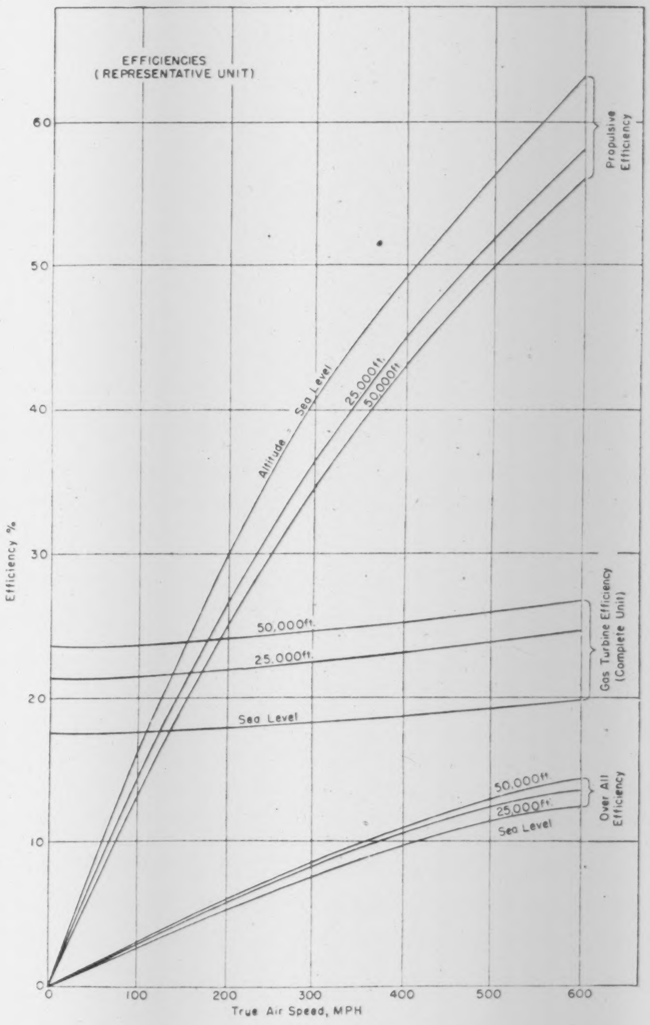

FIG. 4 EFFICIENCY CURVES OF JET-PROPULSION POWER PLANT

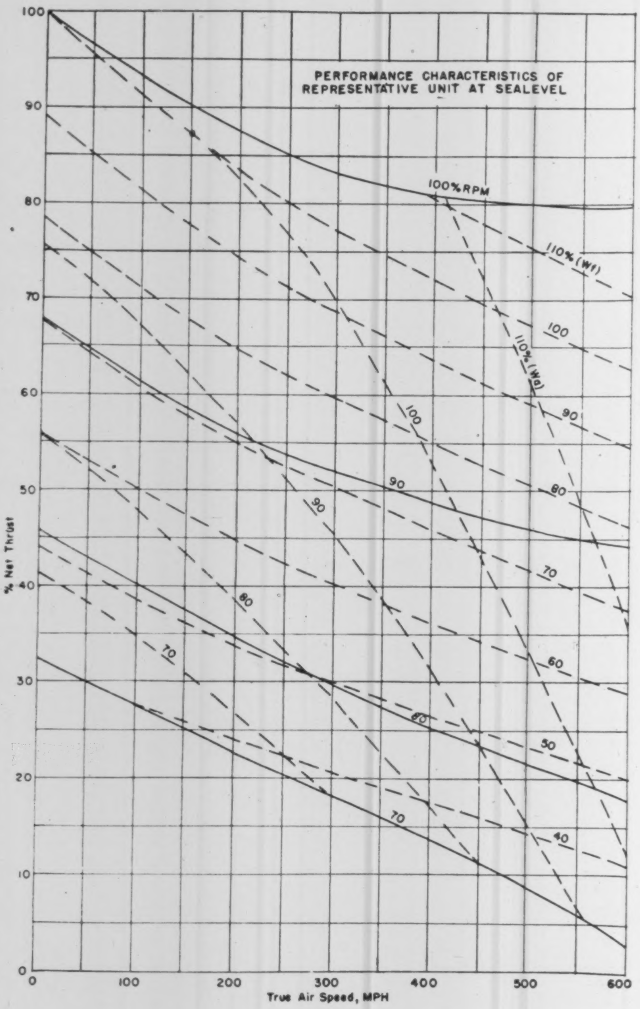

FIG. 5 PERFORMANCE CHARACTERISTICS OF REPRESENTATIVE UNIT AT SEA LEVEL

The over-all efficiency is defined as

$$\eta_t = \frac{E_p}{E_f} = \frac{\omega_a}{\omega_f}\,\frac{V(V_6 - V)}{gJh}$$

In Figs. 5, 6, and 7 are plotted the variations in thrust, fuel flow, and air flow, as they vary with changing rpm on the unit and for various plane velocities. In establishing these curves, the power plant analyzed is one with attainable and practicable efficiencies as before. The thrust, air flow, and fuel flow are indicated as 100 per cent under sea-level static conditions of operation with dry air assumed at 14.7 psia, and at 15 C or 59 F. A complete study of the three curves covering sea level, 25,000 ft, and 50,000 ft, will reveal the characteristics of the performance of this assumed power plant under any practicable condition of operation. In the comparison of these curves with drag curves on the airplane, it should be borne in mind that the drag of the aircraft properly designed for this application is not that of yesterday's aircraft. The new airplane must and can be a cleanly designed one with its drag reduced to a new practicable minimum.

# Appendix

### NOMENCLATURE

In the analysis of performance of the jet-propulsion power plant, the following nomenclature is used:

$N$ = jet-propulsion-unit revolutions per minute

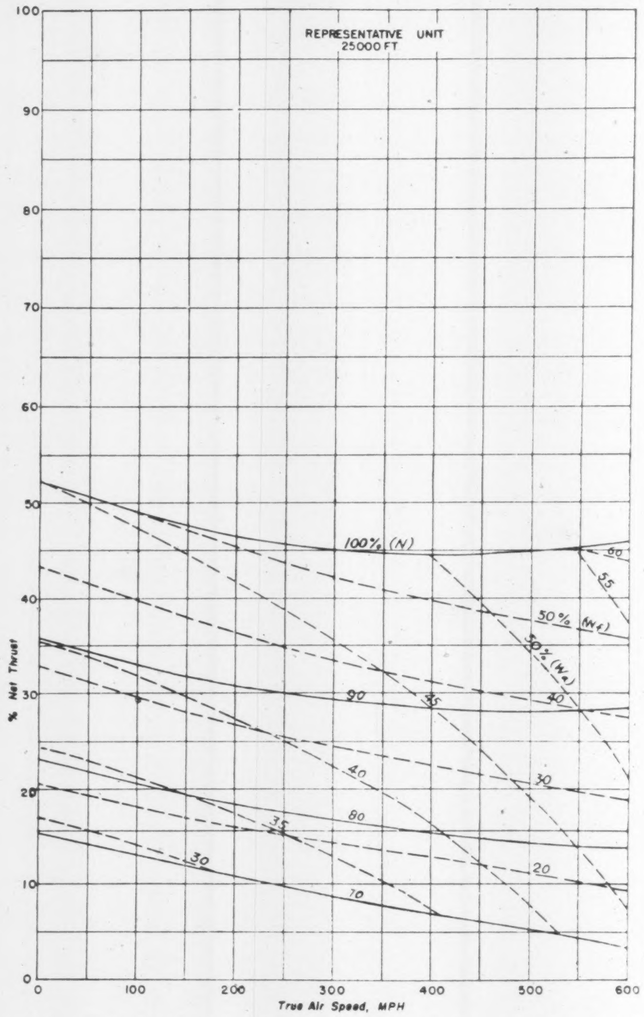

FIG. 6 PERFORMANCE CHARACTERISTICS OF REPRESENTATIVE UNIT AT 25,000 FT

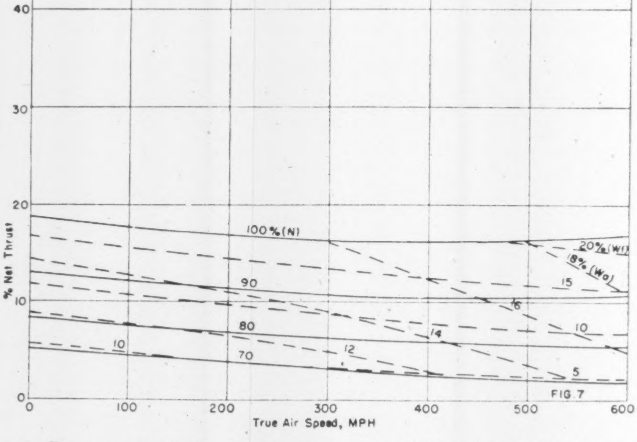

FIG. 7 PERFORMANCE CHARACTERISTICS OF REPRESENTATIVE UNIT AT 50,000 FT ALTITUDE

$V$ = plane speed, fps
$V_5$ = exhaust-nozzle throat velocity, fps
$(V_5)_s$ = sonic velocity at exhaust-nozzle throat, fps
$V_6$ = equivalent exhaust-jet velocity, fps
$F_0$ = ram drag, lb
$F_5$ = net thrust, lb
$\omega_f$ = fuel flow, lb per hr
$W_f$ = fuel power input
$\omega_a$ = air flow, lb/sec.
$r$ = fuel/air ratio, lb/sec/lb/sec
$P$ = pressure, unspecified, psia
$P_0$ = ambient pressure, psia
$P_1$ = compressor-inlet total pressure, psia
$P_2$ = compressor-discharge total pressure, psia
$P_3$ = turbine-inlet total pressure, psia
$P_4$ = turbine-discharge total pressure, psia
$P_5$ = exhaust-nozzle-throat static pressure, psia
$T$ = temperature, unspecified, abs
$T_0$ = ambient temperature, abs
$T_1$ = compressor-inlet total temperature, abs
$T_2$ = compressor-discharge total temperature, abs
$T_3$ = turbine-inlet total temperature, abs
$T_4$ = turbine-discharge total temperature, abs
$T_5$ = exhaust-nozzle-throat static temperature, abs
$E_p$ = power input to plane
$E_a$ = power input to air
$E_f$ = energy input of fuel
$\eta_p$ = propulsive efficiency
$\eta_g$ = gas-turbine efficiency (complete unit)
$\eta_t$ = over-all efficiency
$\eta_0$ = ram efficiency
$\eta_1$ = compressor temperature-rise efficiency
$\eta_2$ = compressor pressure coefficient
$\eta_3$ = combustion efficiency
$\eta_4$ = total expansion efficiency
$A_3$ = turbine-nozzle-throat effective area, sq ft
$A_5$ = exhaust-nozzle-throat effective area, sq ft
$C_{p1}$ = specific heat for compression (assumed constant)
$C_{p2}$ = specific heat for combustion (assumed constant)
$C_{p3}$ = specific heat for expansion (assumed constant)
$\rho_5$ = density at throat of exhaust nozzle
$Q$ = volume flow at compressor inlet, cfm
$D$ = compressor impeller diameter
$K$ = $C_p/C_v$, for compression
$k$ = $C_p/C_v$, for expansion
$C$ = ratio of $P_3/P_2$
$h$ = heating value of fuel per lb
$R$ = gas constant
$J$ = mechanical equivalent of heat
$g$ = acceleration of gravity
$C_1, C_2, C_3$ = constants

### BASIS OF REPRESENTING PERFORMANCE

A method of representing jet-propulsion-unit and plane performance, as originally used by the British, is to plot the following quantities as functions of $N/\sqrt{T_0}$ and $V/\sqrt{T_0}$

$$F/P_0 \qquad T/T_0$$

$$\omega_a\sqrt{T_0}/P_0 \qquad P/P_0$$

$$\omega_f/P_0\sqrt{T_0}$$

These quantities can be derived by methods of dimensional analysis as will be shown later. This method assumes that the efficiencies and flow coefficients of all component parts are a function of Mach's number only, or its equivalent $V/\sqrt{T_0}$ and $N/\sqrt{T_0}$.

Fig. 8 shows the operating line of the unit superimposed on the compressor-characteristic curves. The compressor-pressure ratio and efficiency are a function of $N/\sqrt{T_1}$ and $Q/N$. However, $T_1$ is a function only of $V$ and $T_0$, and for a given unit with fixed areas of flow passages. $Q/N$ is not an independent variable but is itself a function of $V/\sqrt{T_0}$ and $N/\sqrt{T_0}$. Thus the plane and unit performance are a function only of $V/\sqrt{T_0}$ and $N/\sqrt{T_0}$. The variation of $Q/N$ with $V/\sqrt{T_0}$ at the lower pressure ratios is due to the fact that the exhaust-jet velocity is subsonic in this region, and a variation of ram pressure ratio varies the turbine inlet temperature and the volume flow at the compressor inlet for a given value of $N/\sqrt{T_1}$. When the exhaust-jet velocity becomes sonic, the curves for various values of $V/\sqrt{T_0}$ merge into a single line. The lowest value of $T_0$ at which the unit will operate stably, that is, without compressor pulsation, is the point at which this operating line intersects the pulsation limit.

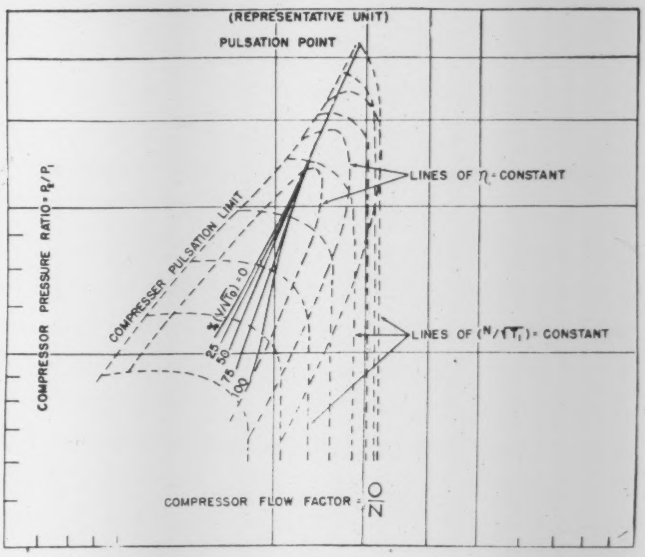

FIG. 8 UNIT OPERATING CURVE ESTABLISHED IN RELATION TO COMPRESSOR CHARACTERISTICS, REPRESENTATIVE UNIT

The quantities plotted to represent performance may be derived by dimensional analysis as follows:

The dimensions used are

$$\text{Mass} = M$$
$$\text{Length} = L$$
$$\text{Time} = t$$
$$\text{Temperature} = T$$

The independent variables may be taken as

| Variable | Symbol | Dimensions |
|---|---|---|
| Revolutions per minute (rpm) | $N$ | $t^{-1}$ |
| Ambient pressure | $P_0$ | $ML^{-1}t^{-2}$ |
| Ambient temperature | $T_0$ | $T$ |
| Plane speed | $V$ | $Lt^{-1}$ |
| Linear dimension | $D$ | $L$ |
| Gas constant | $R$ | $L^2t^{-2}T^{-1}$ |

The dependent variables may be taken as

| Variable | Symbol | Dimensions |
|---|---|---|
| Thrust | $F$ | $MLt^{-2}$ |
| Air mass flow | $w_a$ | $Mt^{-1}$ |
| Fuel power input | $W_f$ | $ML^2t^{-3}$ |
| Pressure | $P$ | $ML^{-1}t^{-2}$ |
| Temperature | $T$ | $T$ |

For each dependent variable, dimensionless groups can be expressed, as for example

$$f[FP_0T_0DR,\ VP_0T_0DR,\ NP_0T_0DR] = 0$$

This results in a dimensionless group for each dependent variable as a function of $V/\sqrt{RT_0}$ and $ND/\sqrt{RT_0}$.

The dimensionless groups are

$$F/P_0D^2$$
$$w_a\sqrt{RT_0}/P_0D^2$$
$$W_f/P_0D^2\sqrt{RT_0}$$
$$P/P_0$$
$$T/T_0$$

For any given plane and unit it is convenient to eliminate $D$ and $R$ and replace $W_f$ by $\omega_f$. The resulting groups which are proportional to the dimensionless groups then become the ones first listed.

### DERIVATION OF EQUATIONS

The general equations of the unit performance derived later are equations of the quantities used to represent performance as just listed, as a function of $V/\sqrt{T_0}$ and $N/\sqrt{T_0}$. The derivations are based on the following assumptions:

1 All efficiencies and flow coefficients are a function only of $V/\sqrt{T_0}$ and $N/\sqrt{T_0}$.

2 There is continuity of flow through the compressor, turbine nozzles, and exhaust-jet nozzle. It is not practical to write an equation for flow through the compressor as a function of compressor performance. Therefore, continuity of flow is assumed through the turbine nozzles and exhaust nozzle, presupposing a known compressor performance, or trial-and-error or graphical methods of solution can be used.

The general operation is as follows:

Referring to Fig. 2, the compression takes place in two steps. Ram compression occurs from 0–1 when air is taken aboard and decelerated from plane speed to zero velocity, relative to the unit. This results in a temperature rise at the compressor inlet over ambient temperature and a pressure rise of an amount depending on the ram efficiency. The second step of compression is in the compressor from 1–2 and the air is discharged into the combustion chambers. There is some loss of pressure in the combustion chambers. Expansion of the hot gas takes place from 3–5, part of the expansion energy being used to drive the compressor and part being used to generate high exhaust velocity for the propulsion jet. The pressure at 5 may be higher than ambient, in which case part of the thrust is pressure thrust. The flow through the turbine nozzles may be assumed to be supersonic at practically all operating conditions. The flow through the exhaust-jet nozzle is usually subsonic at lower values of $V/\sqrt{T_0}$ and $N/\sqrt{T_0}$, and supersonic at higher values.

The equations of the performance characteristics may be derived as follows:

*Compression in Ram:* The ram temperature rise is

$$T_1 - T_0 = \frac{V^2}{2gJC_{p1}} = C_1V^2 \quad\text{.............}[1]$$

also

$$T_1 - T_0 = \frac{T_0}{\eta_0}\left[\left(\frac{P_1}{P_0}\right)^{\frac{K-1}{K}} - 1\right] \quad\text{..........}[2]$$

or the ram pressure ratio is

$$\frac{P_1}{P_0} = \left[1 + C_1\eta_0\left(\frac{V}{\sqrt{T_0}}\right)^2\right]^{\frac{K}{K-1}} \quad\text{...........}[3]$$

*Compression in Compressor:* The compressor temperature rise is given by the following expression

$$T_2 - T_1 = \frac{1}{gJC_{p1}}\left(\frac{\pi D}{60}\right)^2\frac{\eta_2}{\eta_1}N^2 = \frac{C_2\eta_2}{\eta_1}N^2 \quad\text{.......}[4]$$

also

$$T_2 - T_1 = \frac{T_1}{\eta_1}\left[\left(\frac{P_2}{P_1}\right)^{\frac{K-1}{K}} - 1\right] \quad\text{..........}[5]$$

since

$$\frac{T_1}{T_0} = 1 + C_1\left(\frac{V}{\sqrt{T_0}}\right)^2$$

the compressor pressure ratio is

$$\frac{P_2}{P_1} = \left[1 + \frac{C_2\eta_2\left(\frac{N}{\sqrt{T_0}}\right)^2}{1 + C_1\left(\frac{V}{\sqrt{T_0}}\right)^2}\right]^{\frac{k}{k-1}} \quad\text{.........}[6]$$

*Expansion in Turbine and Jet.* The energy of expansion is used partly to drive the compressor and partly to generate velocity for the propulsion jet. The following expression can thus be written:

Expansion energy = compressor energy + jet energy (neglecting shaft losses)

An expression for the expansion energy may be written

$$\text{Expansion energy} = \eta_4T_3\left[1 - \frac{1}{\left(\frac{P_3}{P_5}\right)^{\frac{k-1}{k}}}\right] \quad\text{.....}[7]$$

which for convenience will be expressed

$$\text{Expansion energy} = f_1T_3 \quad\text{..............}[8]$$

The compressor energy may be written

$$\text{Compressor energy} = \frac{C_2\eta_2}{\eta_1}\frac{C_{p1}}{C_{p3}}N^2 \quad\text{..........}[9]$$

The following relation will also be assumed

$$\text{Compressor energy} = f_2T_3 \quad\text{.............}[10]$$

where $f_2$ will be defined later.

The expression for jet velocity energy is

$$\text{Jet energy} = \frac{V_5{}^2}{2gJC_{p3}} \quad\text{..............}[11]$$

thus the equation of energy balance becomes

$$f_1T_3 = f_2T_3 + \frac{V_5{}^2}{2gJC_{p3}} \quad\text{...............}[12]$$

To express continuity of flow through the turbine nozzles and exhaust-jet nozzle, the following expressions may be written: The flow through the turbine nozzles with sonic velocity at the throat of the nozzles is given by the equation

$$\omega_a = 144\left(\frac{k}{k-1}\right)\left(\frac{k+1}{2}\right)^{\frac{1}{1-k}}\sqrt{\frac{2g(k-1)}{JC_{p3}(k+1)}}\frac{A_3P_3}{\sqrt{T_3}} \quad\text{...}[13]$$

$$\omega_a = \frac{C_3A_3P_3}{\sqrt{T_3}} \quad\text{..................}[14]$$

The flow through the exhaust nozzle may be derived as follows

$$\omega_a = \rho_5A_5V_5 \quad\text{......................}[15]$$

where

$$\rho_5 = \frac{P_5}{RT_5} = \frac{144}{JC_{p3}}\left(\frac{k}{k-1}\right)\frac{P_5}{T_3(1-f_1)} \quad\text{......}[16]$$

$$V_5 = \sqrt{2gJC_{p3}\,T_3\,(f_1 - f_2)} \quad \ldots\ldots\ldots\ldots \quad [17]$$

$$\omega_a = 144\left(\frac{k}{k-1}\right)\sqrt{\frac{2g}{JC_{p3}}(f_1 - f_2)}\;\frac{A_5P_5}{(1-f_1)\sqrt{T_3}} \quad \ldots [18]$$

Eliminating $\omega_a$ between Equations [13] and [18] gives

$$f_2 = f_1 - \left(\frac{k+1}{2}\right)^{\frac{2}{1-k}}\left(\frac{k-1}{k+1}\right)\left(\frac{A_3}{A_5}\right)^2\left(\frac{P_3}{P_5}\right)^2(1-f_1)^2$$

It will be noted that for a given unit the effective area ratio $(A_3/A_5)$ is a function of $P_3/P_5$

$$\frac{P_3}{P_5} = C\left(\frac{P_1}{P_6}\right)\left(\frac{P_2}{P_1}\right)$$

for subsonic flow in the exhaust nozzle, and $(P_3/P_5)$ = constant for supersonic flow. Therefore $f_1$ and $f_2$ are functions only of $v/\sqrt{T_0}$ and $N/\sqrt{T_0}$.

The general equations expressing performance of the unit may now be written.

*Turbine-Inlet Temperature*. From Equations [9] and [10].

$$\frac{T_3}{T_0} = \frac{C_2\eta_2}{f_2\eta_1}\,\frac{C_{p1}}{C_{p3}}\left(\frac{N}{\sqrt{T_0}}\right)^2$$

*Air Flow*. From Equations [9], [10], and [14]

$$\omega_a = C_3A_3P_3\sqrt{\frac{f_2\eta_1}{C_2\eta_2}\,\frac{C_{p3}}{C_{p1}}\,\frac{1}{N}}$$

$$\frac{\omega_a\sqrt{T_0}}{P_0} = C_3A_3\sqrt{\frac{f_2\eta_1}{C_2\eta_2}\,\frac{C_{p3}}{C_{p1}}}\left(\frac{P_3}{P_0}\right)\frac{1}{\left(\dfrac{N}{\sqrt{T_0}}\right)}$$

*Fuel Flow*. The expression for fuel flow will be much simplified if expressed in terms of fuel/air ratio $(r)$

$$r = \frac{C_{p2}\,(T_3 - T_2)}{\eta_3h}$$

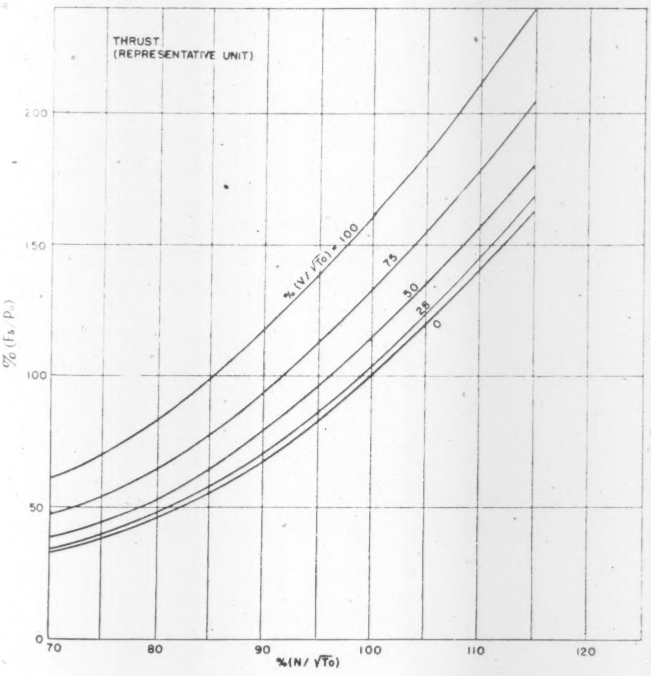

FIG. 9 THRUST, REPRESENTATIVE UNIT

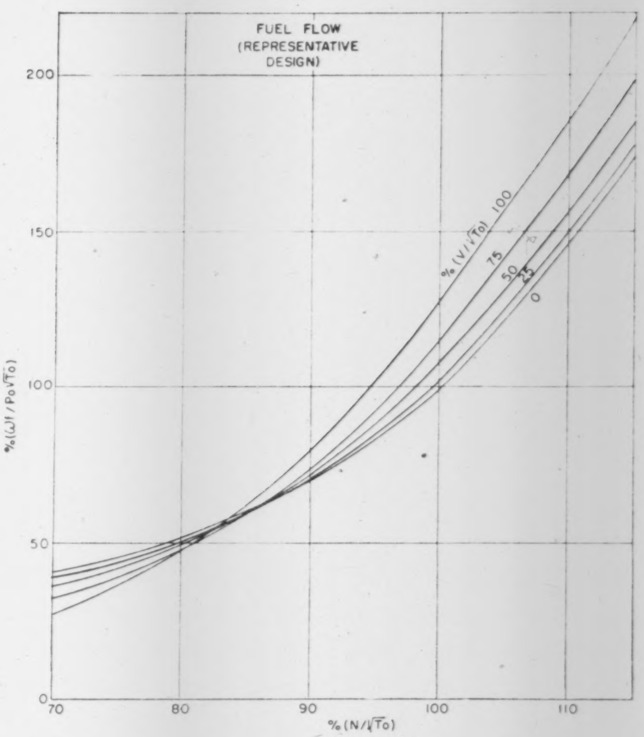

FIG. 10 FUEL FLOW, REPRESENTATIVE DESIGN

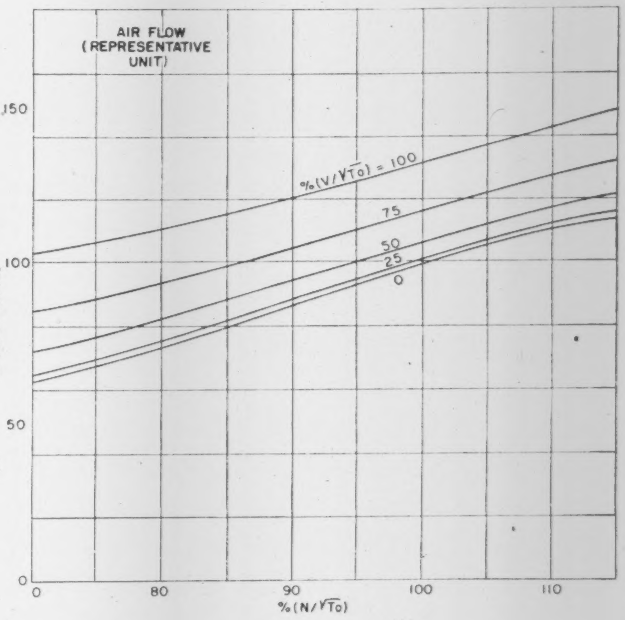

FIG. 11 AIR FLOW, REPRESENTATIVE UNIT

From Equations [9], [10], and [4]

$$r = \frac{C_{p2}}{\eta_3h}\left[\left(\frac{C_{p1}}{f_2C_{p3}} - 1\right)\frac{C_2\eta_2}{\eta_1}N^2 - C_1V^2 - T_0\right]$$

$$\frac{r}{T_0} = \frac{C_{p2}}{\eta^3h}\left[\left(\frac{C_{p1}}{f_2C_{p3}} - 1\right)\frac{C_2\eta_2}{\eta_1}\left(\frac{N}{\sqrt{T_0}}\right)^2 - C_1\left(\frac{V}{\sqrt{T_0}}\right)^2 - 1\right]$$

*Jet Thrust*. The expression for thrust of flow through a non-expanding exhaust nozzle may be written

$$F_5 = \frac{\omega_aV_5}{g} + 144\,A_5\,(P_5 - P_0)$$

From Equations [17] and [18]

$$F_5 = 144\ A_5\left[\left(\frac{2k}{k-1}\right)\left(\frac{f_1 - f_2}{1 - f_1}\right) P_5 + (P_5 - P_0)\right]$$

$$\frac{F_5}{P_0} = 144\ A_5\left[\left(\frac{2k}{k-1}\right)\left(\frac{f_1 - f_2}{1 - f_1}\right) \frac{P_5}{P_0} + \left(\frac{P_5}{P_0} - 1\right)\right]$$

In the foregoing equations when sonic velocity exists at the throat of the exhaust-jet nozzle $f_1$, $f_2$, and $(P_3/P_5)$ become constant. The condition at which sonic velocity is reached may be found as follows

From Equation [17]

$$V_5 = \sqrt{2g\,JC_{p3}\,T_3(f_1 - f_2)}$$

$$(V_5)_s = \sqrt{g\,JC_{p3}(k-1)T_3}$$

$$T_5 = T_3(1 - f_1)$$

Solving for $V_5$ equal to $(V_5)_s$

$$f_2 = \left(\frac{k+1}{2}\right) f_1 - \left(\frac{k-1}{2}\right)$$

Illustrations of the basic curves of gas-turbine performance, based on the foregoing expressions, are shown in Figs. 9, 10, and 11. These curves may be expanded into various plots of performance at various altitudes, plane speeds, and rpm. It may be more convenient in some cases to plot engine performance alone as a function of $(P_1/P_0)$ and $N/\sqrt{T_1}$, in which case performance is expressed as

$$\left(\frac{F}{P_1}\right)\left(\frac{\omega_a\sqrt{T_1}}{P_1}\right) \quad \text{and} \quad \left(\frac{\omega_f}{P_1\sqrt{T_1}}\right)$$

This may be more useful if the ram efficiency is an unknown factor.

# Basic Principles of Supervision

(*Continued from page 703*)

work and finds that he is an old hand who has been through the company training school. He gives him such detailed instruction as fits the needs of the case, starts him at work, and checks at least the first steps of his performance. He also inquires of workmen who are neighbors of the absent men as to possible ill-health or other reasons for failing to report for work. Finding that the wife of one worker was seriously ill, he informs the Employee Welfare Committee and plans also to make a personal visit at the first opportunity.

By this time one of the other workmen has come up to ask a question. One of the castings which he has started to machine has a bad gouge and it looks as though it might not "clean up" when the finish cut is made. It is an expensive casting and is needed to complete the order. Shall the workman continue to machine it or throw it aside and wait for another?

The gouging was done by another one of the foreman's workmen, the grinder or snagger, whose job it was to grind off the sprues and rough-dress the casting as required. Something has to be done. The foreman, being in charge of both workmen, is definitely responsible. He must decide what to do about the damaged casting, also he must decide what to do about the grinding operation so that there will be no repetition of such faulty work. Incidentally, he finds that the grinder injured his hand when the casting slipped.

The foreman gives first consideration to the injured workman and sees to it that first-aid and medical service are provided. He investigates the accidental injury for cause, finds the remedy, and applies it. Constantly, in addition to the immediate problems of keeping the wheels of progress turning, he checks and studies each individual step and procedure to see in what way it can be improved with regard to quality, volume, cost in dollars and manpower, and safety to personnel.

Still another employee may have a real or fancied grievance. A qualified foreman has knowledge of men—commonsense knowledge of motivating characteristics and of attitudes—he understands them and is truly fair and sympathetic, yet is not misled by the occasional attempt of a workman to "put something over." So he makes use of his knowledge and abilities in the case of the reported grievance and, finding in this instance that it is well founded and within his own authorization to adjust, settles the situation on the spot satisfactorily to all concerned. Should the grievance relate to matters beyond his power to correct, he would have referred it to the proper authorities, together with his own comments and recommendations, and promised the workman that full and fair consideration would be given. Then he would have fulfilled his promise, knowing that half-way measures on his part would destroy the respect and confidence of his group, without which he could not be successful.

Many occurrences tend to interrupt and interfere with the smooth and orderly functioning of his department. Visitors, including inspectors of several kinds, must be shown around the works. One workman complains that he doesn't feel well. The foreman "sizes him up" and decides that he should report to the medical department. Another workman wants to be transferred to other work. A conference is held in the "front office." Job specifications are changed. Orders for new work are received. Inventory must be taken. Repairs are required.

Notwithstanding such inescapable distractions, the labor of men with machines and materials must, by means of dynamic supervision, result in safe and efficient production. If the basics of supervision as herein described are known, understood, and practiced, safe and efficient production will result.

Any practicing foreman will agree that this example is by no means far-fetched. Events and circumstances not necessarily of similar nature but which require similar forms of "action" on his part occur daily at frequent intervals. The average foreman doesn't run a training school. He has no time to do so, but he can and should take up where the training school leaves off and provide such additional training and instruction as may be necessary to make sure that each person under his supervision knows exactly how his job is to be done, is capable of doing it safely and properly, and actually does it that way.

The foreman doesn't have ideal conditions to deal with. He is an exceptionally busy person if he is really on the job. What he needs to know about business economics and business management, labor relations, psychology, etc., is what can be boiled down out of such subjects into short crisp bits of information which he can put immediately to good use in solving his everyday problems. It is a constant whole-time effort to maintain quality and volume of production, to do it safely and efficiently and with fairness to himself, his workmen, and management.

This is foremanship. This is the dynamic part of supervision, and this is the reason for placing emphasis on training and instructing, giving orders, checking worker performance, on correcting and especially on preventing unsafe and improper practices and conditions.

# *Electrical* IGNITION *for* AIRCRAFT *Internal-Combustion* HEATERS

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### INTRODUCTION

PRIOR to the installation of the ignition system to be described, field reports on the operation of internal-combustion heaters indicated that consistent difficulty was encountered in ignition of such heaters installed in Douglas-built aircraft at temperatures below 0 F at all altitudes, and at altitudes above 15,000 ft at all temperatures. Laboratory tests under conditions simulating those encountered in the field fully corroborated the field reports. In addition, the ignition head was prone to become fouled by carbon and other combustion deposits to an extent which prevented ignition under any circumstances. Since current practice for regulation of heat production depends on the proportion of heater "off" to "on" time, i.e., on-off cycling, the latter difficulty was serious.

The research laboratories of the authors' company were requested to consider the practicability of improving ignition and operation on a "quick-fix" basis to meet the following specifications:

1 The quick fix should not require basic alteration of current heater installations, primarily to allow prompt and ready modification in the field.

2 Ignition should be possible under the most extreme environmental conditions likely to be encountered. The conditions were defined as follows:

(*a*) Any altitude from sea level to 30,000 ft.

(*b*) Any temperature between 70 F and —65 F.

(*c*) Any combustion-air pressure between 7 and 33 in. of water (corresponding to a speed range of 120 to 260 mph) at sea level, and a range of combustion-air pressure between 7 and 13 in. of water (corresponding to a speed range of 190 to 260 mph) at 30,000 ft. The implications of this specification will be discussed later.

3 As an immediate objective, the normal period between service checks in the field should be greater than 50 hr of heater operation, with an eventual period of greater than 500 hr desired.

### GENERAL CONSIDERATIONS

In the consideration of the general problem of aircraft internal-combustion heaters, there are important limitations imposed upon the design, some of which are as follows:

1 The absolute gaseous pressure in the combustion chamber is closely that of the outside atmosphere, which implies that the pressure may vary from approximately 15 psi at sea level to one fourth of 15 psi or less at altitude.

2 No simple and entirely successful carburetion system is available. Further, the complexity of a carburetor is such that spray nozzles are preferable if their performance can be made satisfactory.

3 The allowable pressures which may be applied to the nozzle must be kept small, below, for example, 15 or 20 psi. Under some conditions of use the heater is required to perform with fuel pressures as low as 3 or 4 psi. This introduces the difficult problem of securing adequate mixture because of highly incomplete atomization with conventionally designed nozzles at such low fuel pressures.

4 The heater is required to ignite when both the heater and the fuel are well below the flash point of aviation gasoline.[5]

In summary, the heater must operate under wide variations of air-fuel ratio, condition of mixture, temperature, and altitude.

Of the possible methods available for igniting a combustible mixture, two are applicable, (1) an electrically heated glow coil to obtain a high local temperature and (2) electrical spark ignition. Difficulties encountered in the application of glow coils include slow starting even under moderate conditions, excessive power requirements, and stringent material requirements to avoid erosion.

Early experiments gave definite indication that the use of electrical spark ignition was fundamentally sound, and that such a system gave promise of a more immediate solution to the problem.

It should be pointed out that the decision to prosecute the studies of electrical ignition were not based on consideration of ignition in an internal-combustion engine, inasmuch as the conditions differ so widely from those found in the combustion heater. Conditions in the internal-combustion engine may be characterized as being somewhat constant and optimum. Specifically, engine ignition is relatively favorable for the following reasons.

1 At the instant of ignition there is no blast of air tending to extinguish the spark.

2 The combustible mixture has a relatively high temperature prior to ignition.

3 Due to compression, the gaseous density is high. The effect of density upon ignitibility will be discussed later.

4 The mixing of air and the gasoline vapor is essentially complete.

5 The weight ratio of gasoline to air lies in a range favorable for ignition.

### SPARKING VOLTAGE OF SPARK PLUGS

Evidence is given in a later section on the influence of the sparking voltage upon ignition. For completeness, some of the elementary considerations dealing with sparking voltages are included here.

To a first approximation, the voltage at which spark breakdown occurs between a pair of electrodes depends upon the following.

(*a*) The shape and surface condition of the electrodes.

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[2] Electrical Laboratory. (Assistant Professor, Swarthmore College, on leave.)

[3] Analytical Group Engineer.

[4] Supervisor, Mechanical Laboratory.

Contributed by the Heat Transfer Division and presented at the Aviation War Conference, Los Angeles, Calif., June 11–14, 1945, of The American Society of Mechanical Engineers.

[5] The term flash point is used here in the sense defined in the A.S.T.M. Standard, according to which the flash point is the minimum temperature at which a standard flame will flash the fuel vapor. The vapor pressure of 99-octane aviation gasoline, Specification AN-F-27A, is less than 7 psi at 100 F, which implies that the defined flash point is above —10 F. Refer to W. A. Gruse and D. R. Stevens, "Chemical Technology of Petroleum," McGraw-Hill Book Company, Inc., New York, N. Y., 1942.

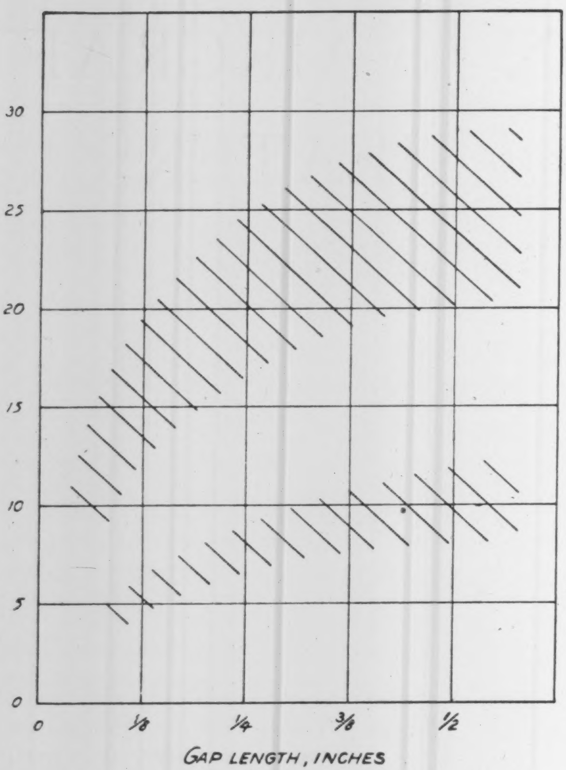

FIG. 1 CREST VOLTAGE ACROSS A GAP AS A FUNCTION OF GAP WIDTH

(The upper region indicated refers to sea-level conditions; the lower, to 30,000 ft. The regions indicate the variation in voltage which may be anticipated with a given pair of electrodes under actual conditions of surface, etc.)

(*b*) The distance between the electrodes.

(*c*) The dielectric strength of the gas between the electrodes.

The functional relationship between these parameters is summarized by Paschen's law, $V = K \rho s$, where $V$ is the spark breakdown voltage, $K$ is a constant for a given gas and electrode shape, $\rho$ is the gaseous density, and $s$ is the distance of electrode separation. Values of $K$ are given by Peek.[6] The sparking voltage is seen to depend strongly upon the altitude and temperature, since each of these factors affects density. A temperature change from room ambient to —65 F corresponds to an increase in density of approximately 15 per cent, while an altitude change from sea level to 30,000 ft produces a reduction in density of approximately 65 per cent.

For certain electrode configurations and gaseous densities, space charge or corona may be present in the region between the electrodes. For such cases, there may be significant nonlinear deviations from Paschen's law. Usually, the predicted voltage is too high. In addition, the breakdown voltage will be found to be somewhat dependent upon the voltage generator.

The dielectric strength of a gasoline vapor-air mixture is within 95 per cent of that of pure air for all anticipated fuel-air ratios. The variation of breakdown voltage with electrode separation at sea level and 30,000 ft is shown in Fig. 1.

### CHARACTER OF SPARK DISCHARGE

The character of the spark discharge obtained from high-voltage coils of either the induction or magneto type differs little. The topic has been studied extensively.[7] Referring to Fig. 2, it is seen that the electrical sequence is initiated by closing of the contact, which allows current to flow through the primary of the coil. The current rises relatively slowly, building up the magnetic field. When the flow of direct current is interrupted by opening the contact, rapid decay of the magnetic field begins since the time constant is effectively shortened, and the time rate of current change is high, particularly since the circuit is oscillatory. The instantaneous voltage across the secondary, being proportional to the time rate of flux decay and hence primary current, rises very rapidly to the critical potential of the gap, and a spark passes between the electrodes. The time delay between application of the initial potential and gaseous breakdown is exceedingly small; no direct measurements of the interval have been reported.

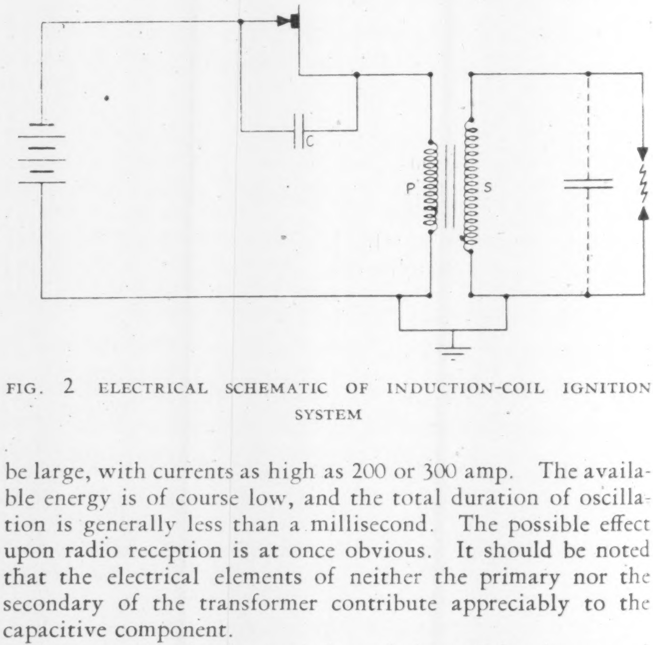

FIG. 2 ELECTRICAL SCHEMATIC OF INDUCTION-COIL IGNITION SYSTEM

The section of the leads adjacent to the gap has a finite, though small, distributed capacitance and inductance. The capacitance becomes charged to the critical potential, and when breakdown occurs, the accumulated charge discharges through the gap and oscillation ensues at the natural frequency of the system comprising the short section of leads and the gap. The frequency is accordingly high, commonly having components in the range extending above 10 megacycles. This first discharge through the gap is referred to as the "capacitive"[7] component, indicative of its source of energy. Since the circuit has a low dissipation factor, i.e., a large $Q$, the power can be large, with currents as high as 200 or 300 amp. The available energy is of course low, and the total duration of oscillation is generally less than a millisecond. The possible effect upon radio reception is at once obvious. It should be noted that the electrical elements of neither the primary nor the secondary of the transformer contribute appreciably to the capacitive component.

The resonant circuit consisting of the tuned primary and secondary has a much longer period. The natural-frequency oscillations of the latter circuit are generally not apparent until the capacitive discharge has ceased. The fundamental frequency of oscillation of the latter component generally lies in the audio range. The energy is derived mainly from the inductively stored field energy, hence the title "inductive"[7] component. While the peak current lies in the milliampere range, the total energy expended is relatively high, being roughly that supplied to the primary of the coil. The relative time, current, and voltage relationships are qualitatively shown in Fig. 3.

The foregoing description is that of the customary discharge; in some cases, one or the other component may be suppressed, or its character altered; the character of the discharge is

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[6] "Dielectric Phenomena in High Voltage Engineering," by F. W. Peek, Jr., McGraw-Hill Book Company, Inc., New York, N. Y., 1929. A summary of the proof of the applicability of Paschen's law and Peek's formulas is given in "The Sparking Voltage of Spark Plugs," by F. B. Silsbee, N.A.C.A. Report No. 202, 1925.

[7] "The Control of Ignition-Coil Discharge Characteristics," by G. I. Finch and R. W. Sutton, Proceedings of the Physical Society of London, Eng., vol. 45, 1933, pp. 288–306; also "Induction Coil, Theory and Application," by Edward Taylor Jones, Pitman & Sons, London, Eng., 1932.

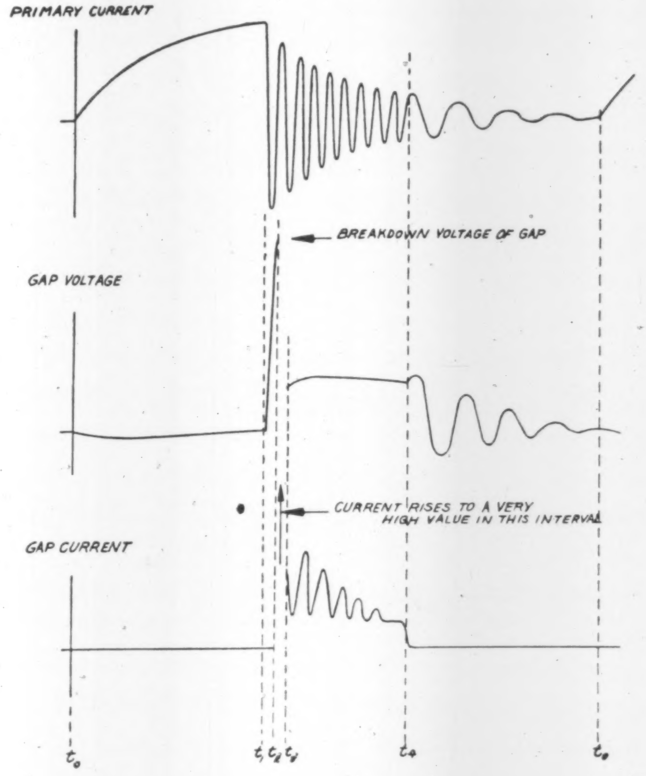

FIG. 3 QUALITATIVE INDICATION OF TIME VERSUS CURRENT AND VOLTAGE RELATIONSHIPS IN AN INDUCTION COIL

(At time $t_0$, the vibrator contact is closed. At $t_1$, the contact is opened and the secondary voltage rises rapidly until time $t_2'$, when the secondary voltage becomes high enough to break the gap electrically. Between $t_2$ and $t_3$, a large high-frequency oscillatory current flows; this constitutes the "capacitive" component. The capacitive component decays rapidly and at $t_3$ the "inductive" low-frequency component becomes apparent. The available stored energy is rapidly dissipated and at $t_4$ is insufficient to support the discharge, and sparking ceases. The current drops to zero, though the voltage difference continues to alternate. Both the current and voltage have a significant direct-current component throughout.)

specifically determined by the electrical parameters of the whole system, both lumped and distributed.

The role of each component in ignition is not clear. There is evidence to support the belief that one or the other alone is mainly responsible for ignition.[8] Naively, it would be expected that the high current and voltage discharge of the capacitive component would make it highly effective; on the other hand, despite the known fact that thermal energy does not alone directly cause ignition in an engine cylinder where the fuel is vaporized, the comparatively higher caloric energy from the inductive component may be indirectly essential to ignition in the present case. The point will be discussed below.

### MECHANISM OF FUEL IGNITION

The physical mechanism by which an electrical spark succeeds in igniting a combustible mixture is not completely understood. According to an early theory, the passage of current through the vapor-air mixture raises the temperature locally to a high enough value to initiate combustion. Corollary to this supposition, the spark energy would be the single parameter describing igniting power. There is conclusive evidence against such a hypothesis.[9]

According to present theory, the actual process is somewhat more complex. Current is conducted through a gas largely by electrons and partly by positive ions, both of which are accelerated by the electrostatic field between the electrodes. Electrical breakdown occurs when the kinetic energy of stray charges is sufficient to produce successive ions upon molecular collision. After breakdown there is a relatively large number of moving ions which lose their energy by two processes, i.e., by creating new ions, and by exciting molecules to a higher than normal energy state. Suitably excited molecules are rendered chemically active. The presence of a sufficient number of molecules so activated will initiate combustion or explosion. The probability of creating a sufficient number of activated molecules is directly proportional to the number of moving ions of a given kinetic energy; the probability rises more sharply with increase in kinetic energy of the ions, the number of ions remaining constant, that is, it may be expected that ignitability can be improved most simply and effectively by increasing the spark-breakdown voltage.

Basic data on the relationship among the quantities igniting power, spark energy, and spark voltage have been given by Paterson and Campbell.[9] A portion of their results is shown in Fig. 4. The strong dependence of ignitibility on voltage is apparent. It should also be noted that there is an optimum gasoline-air mixture from the standpoint of ignition; further, lean mixtures require both relatively high spark voltages and energy. The curves are not, however, quantitatively applicable to the current problem; they apply to equilibrium air-gasoline mixtures having a range of absolute pressures of 50 psi to 90 psi at temperatures of 50 C. Further, the gasoline used probably had somewhat different properties from those of present aviation fuel. Though Paterson and Campbell found that, over the range of pressures tested, the ignition characteristics were independent of pressure, it may not be correct to extrapolate such a result to the absolute pressures of 2 or 3 psi encountered in the present problem at altitudes ranging

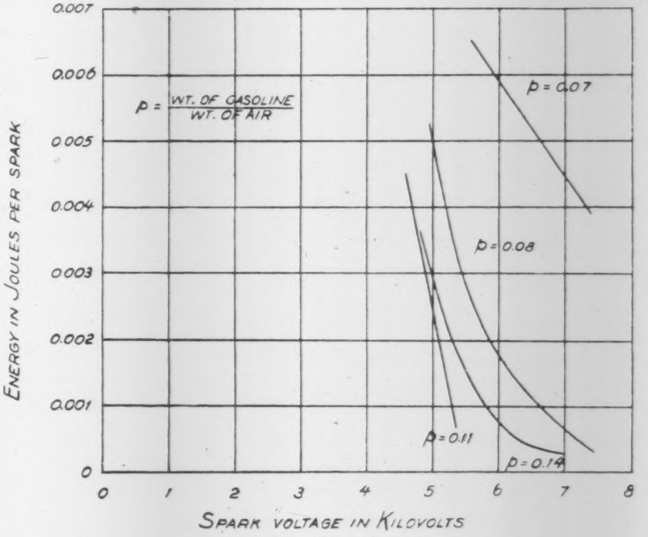

FIG. 4 RELATIONSHIP BETWEEN MINIMUM SPARK ENERGY AND VOLTAGE REQUIRED FOR IGNITION OF AIR-GASOLINE MIXTURES, FROM PATERSON AND CAMPBELL[9]

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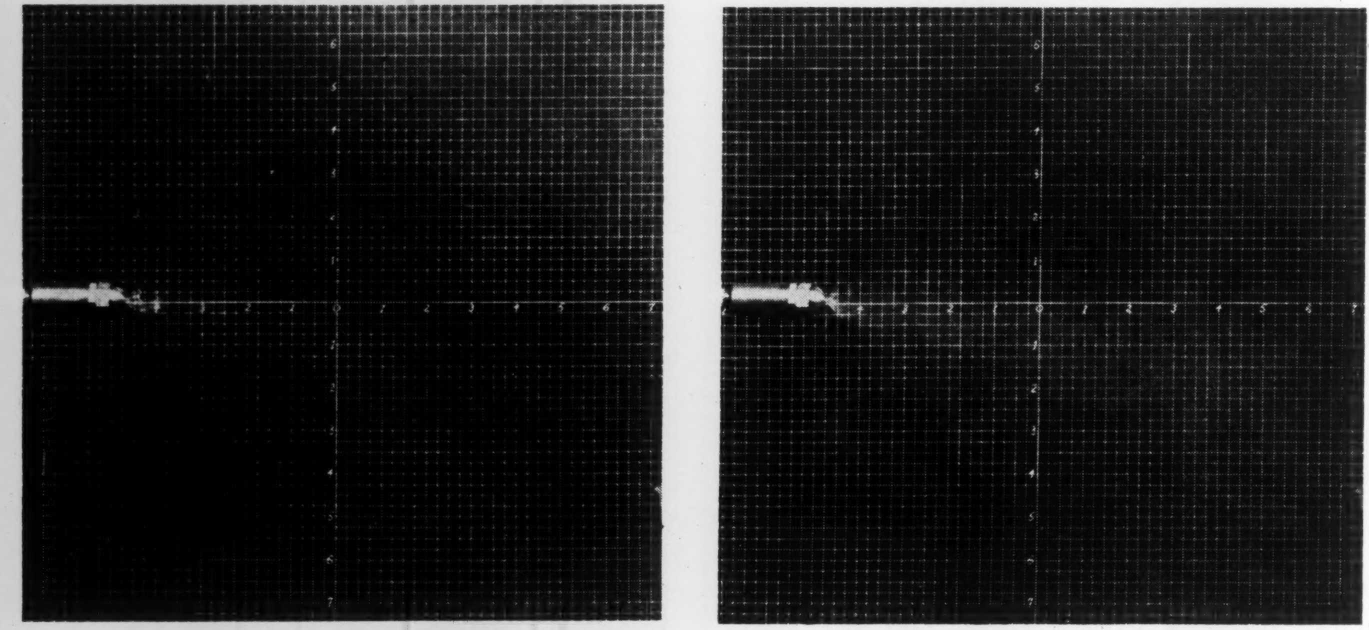
[8] "The Effect of Frequency on the Condensed Discharge Ignition of Carbonic Oxide Air Detonating Gas," by G. I. Finch and H. H. Thompson, Proceedings of the Royal Society of London, Eng., vol. 134A, 1932, p. 343.

"An Investigation of the Effectiveness of Ignition Sparks," by M. F. Peters, W. L. Summerville, and M. Davis, N.A.C.A. Report No. 359, 1930.

[9] "The Characteristics of the Spark Discharge and Its Effect in Igniting Explosive Mixtures," by C. C. Paterson and N. Campbell, I.C.E. Subcommittee Report No. 23, May, 1918; Proceedings of the Physical Society, London, Eng., vol. 31, 1919, p. 168.

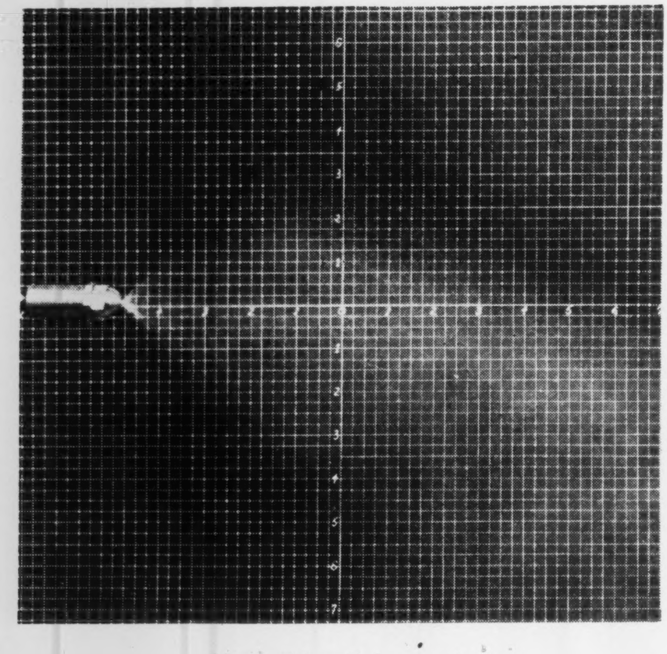
Finch and Thompson, loc. cit.

"Combustion, Flames, and Explosions of Gases," by B. Lewis and G. von Elbe, Cambridge University Press, London, Eng., 1938.



(*a*) 6 Psi applied to nozzle

(*b*) 12 Psi applied to nozzle



(*c*) 18 Psi applied to nozzle

FIG. 5 KODATRON FLASH PICTURES OF GASOLINE SPRAY ISSUING FROM FUEL NOZZLE

up to 50,000 ft. In such a rarefied gas, ignition is rendered difficult because of a low density of suitably activated molecules arising from the combination of low sparking voltage and low gaseous density.[10] On the other hand, the temperature for the lower explosive limit may be lowered at the higher altitudes and, in part, compensate for the difficulty just mentioned.[11]

In summary, the values of minimum required voltage and energy given by Paterson and Campbell may be used only as setting the lower limits necessary for an aircraft heater.

### DETERMINATION OF OPTIMUM SPARK GAP

In the previous sections of this paper the necessity for a wide spark gap has been indicated. The experiments verifying the applicability of the physical principles discussed previously and the sequence of tests leading to the final choice of spark-gap size and its relative position will be described.

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[10] Evidence is given by Edward Taylor Jones,[7] showing that a minimum volume of combustible mixture must be initially ignited in order for the combustion to spread. If the initial volume is too small, heat will be radiated at such a rapid rate that the flame does not propagate. In this connection, one method for examining the effectiveness of ignition sparks and ignition coils has been proposed by M. F. Peters, et al,[8] which depends upon the foregoing fact. In the work described in the N.A.C.A. report, measurements were made of the amount of hydrogen and oxygen chemically combined by an electric spark at liquid-air temperatures and pressures ranging between $^1/_2$ and 2 cm of mercury. The volume of the product so formed was taken as a measure of the effectiveness of the spark. It was presumed that at the low temperature and pressure, combustion would not spread.

[11] This point is treated more fully in a paper entitled, "Gasoline Explosion Pressures," submitted by M. S. Plesset and F. R. Gilmore to the AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

*Air-Fuel Mixture.* Some indication of the lack of good physical mixing of fuel and air can be obtained from Figs. 5 (*a*, *b*, *c*), which show flash photographs of fuel supply obtained with the conventionally designed nozzle in use with the heaters. The nozzle shown has a rating for domestic-oil-burner service of 5 gal of fuel oil per hr with 100 psi applied. The relatively poor atomization at the lower pressures is apparent. The normal operating range of pressures in the heaters is 4 to 24 psi.

At the time the present investigation was initiated, the regulating valve controlling the ram air supply sometimes froze in the open position, permitting high combustion-air delivery to the heater, as implied in the specification given in the introduction. In place of the nominal air-fuel ratio of 20 to 1 at sea level and 10 to 1 at 30,000 ft, the actual air-fuel ratios could become nearly 30 to 1 at sea level and about 20 to 1 at 30,000 ft. Currently, the maximum ratios are 25 to 1 and 15 to 1, respectively. Judging from Paterson and Campbell's data, a minimum of 5000 to 6000 volts sparking potential is therefore predicated at all altitudes At sea level, the ratios are close to the lean explosive limit, and except for the fact that locally the mixture may be richer, ignition would be extremely difficult, if not impossible. Voltages of 10,000 to 12,000 volts are customarily used in automobile and aircraft engines. In using the latter figures as a guide, it must be emphasized that ignition conditions in engines are inherently more favorable.

*Preliminary Testing.* In accordance with the reasoning of the preceding paragraph, a minimum value of 10,000 volts was selected for experimentation. A $^1/_2$-in. gap between $^1/_8$-in. hemispherical electrodes has a sparking potential of about 10,000 volts at 30,000 ft. To obtain experimental verification, a heater combustion head was fitted with a $^1/_2$-in. gap and a quartz observation window. A 30,000-v supply, capable of sparking across the gap, was made from an inverter-type vibrator and a Diesel-type spark coil for use with a 28-volt d-c supply.

In the preliminary experiments, the spark coil was used, as supplied by the manufacturer, with a 4-ohm limiting resistor in series with the primary of the coil. A heater unit with the experimental head was installed in an altitude chamber and starting tests were conducted at room temperature and at altitudes ranging up to 50,000 ft. Starts were essentially instantaneous at 30,000 ft and below. At 40,000 ft, starts generally required a few seconds; at 50,000 ft flame would play about the electrodes and did not always spread. At the highest altitude, with a $^1/_2$-in. gap, breakdown occurs at about 4000 volts, a fact which undoubtedly contributed to the failure.

In this connection, the difficulty with the original ignition system is fairly obvious. A 0.040-in. gap was employed. The sparking voltage for such a gap is of the order of 5000 volts or less at sea level, and at 15,000 ft, above which starting was frequently unreliable, the sparking voltage is 3000 volts or less.

*Minimum Spark Gap.* The preliminary experiments indicated that 8000 volts is a reasonable minimum below which consistent ignition may not be expected; a gap width of at least $^3/_8$ in. is then predicated. Since the use of a $^3/_8$-in. gap to achieve a sparking voltage of 8 kv at high altitudes would require about 25 kv at sea level, it was felt worth while to verify further the minimum voltage requirements. This was done by observing starting characteristics with gaps ranging from $^1/_8$ in. upward in a heater installed in a refrigerated altitude chamber. In addition, the position of the gap relative to the fuel spray was varied and the optimum position determined.

The limiting resistor in series with the spark coil was removed to increase power input to the coil and gap. The secondary output voltage consequently increased appreciably; the life and service performance of the coil are not adversely affected to a significant degree. The starting characteristics are materially improved.

With the latter change, it was found that in the optimum position, $^1/_4$ in. was the minimum allowable gap for consistent starting at 30,000 ft and —65 F. As previously mentioned, ignition is in some respects more difficult at sea level and low temperature, because of the extreme leanness of the air-fuel mixture. Starting was marginal at the higher air flows with a $^1/_4$-in. gap at temperatures below —40 F and sea level. Since the voltage difference between a $^1/_4$-in. gap and a $^3/_8$-in. gap is small, as shown in Fig. 1, and since the performance is significantly better with the wider gap, the $^3/_8$-in. gap was adopted.

As an interesting aside, it has been observed qualitatively that sea-level ignition becomes increasingly difficult as the temperature is lowered from 0 F to —40 F, but that below —40 F the temperature has relatively small effect. If a particular ignition system performs satisfactorily at —40 F, it will probably be satisfactory at —90 F. At —40 F the fuel vapor pressure of aviation gasoline is just sufficient at sea level to yield the limiting lean explosive air-fuel mixture.[12] At any lower temperature, the vapor pressure is below that necessary for initiation of explosion. In effect, then, —40 F marks what might be called the true flash point at sea level. Since, as the altitude is raised, the density decreases, the mixture becomes richer. The temperature marking the limiting lean explosive air-fuel mixture is therefore lowered.

Simple calculation of the energies involved implies that a portion of the caloric energy in the spark may be required to volatilize the liquid gasoline to produce a mixture which is combustible. The average power supplied to the system is about 50 w; assuming a 50 per cent efficiency of energy transfer, this is equivalent to 0.4 w-sec/spark since the sparking rate is 60 per sec. In terms of vaporizing power, this is sufficient to vaporize about 1 mg of fuel per spark. Some such assumption is required, else initiation of combustion would not be possible consistent with the phenomena previously referred to. It may be well to emphasize that the foregoing hypothesis should not be construed as evidence for a thermal theory of electrical ignition; the role of the heat supplied is, in a sense, secondary to the process of ignition.

Recent tests conducted by the Surface Combustion Company with a production model of the Douglas quick-fix ignition system indicate that starting is reliable and nearly instantaneous at altitudes ranging up to and including 45,000 ft and temperatures down to —65 F.[13]

No field installation of an ignition system based upon the present design has ever failed to ignite. A test flight in Alaska may be cited as an example. A C-54 airplane took off and flew to 25,000 ft before the heaters were turned on. The air temperatures were —8 F, ground, and —56 F at 25,000 ft. The heaters lighted nearly instantaneously. It is felt that the evidence is fairly conclusive that properly conducted laboratory tests simulating environmental conditions can be a reliable index of performance in the field.

### THE COMBUSTION HEAD

One other major problem remained to be solved in the investigation. The original commercial heaters were frequently rendered inoperable by carbon formation. In order that the heaters continue to operate and reignite (since cycling, or on-off heat modulation, is customary), it is necessary that the nozzle, the spark plug, and gap be kept clean of carbon and other combustion deposits.

An obvious source of difficulty is apparent from the schematic drawing, Fig. 6, showing the original ignition head which is attached to the combustion chamber. The whole zone encompassed by the head is dead from a combustion standpoint; the mixture is locally very rich (though it may be lean from the

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[12] The mixture referred to is that adjacent to the spark gap in the vapor state and not to the gross mixture supplied externally; it is dependent only upon the vapor pressure of the gasoline under the relevant conditions.

[13] Privately communicated by Mr. Lee Curtin of Surface Combustion Company.

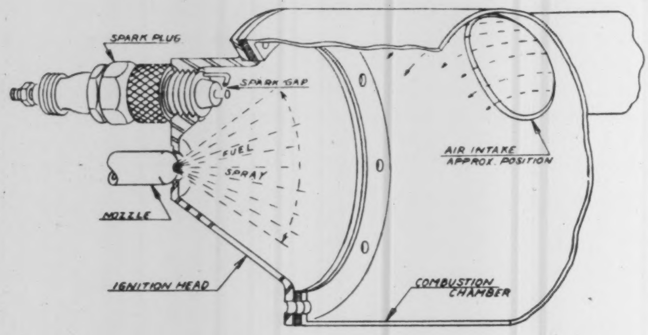

FIG. 6 SCHEMATIC OF IGNITION HEAD ORIGINALLY USED ON INTERNAL-COMBUSTION HEATERS

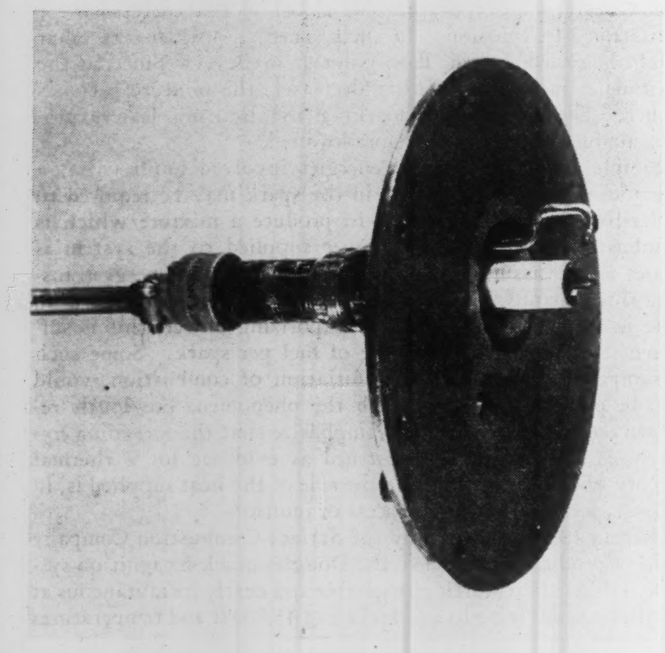

FIG. 7 EXPERIMENTAL FLAT IGNITION HEAD

standpoint of ignition), since a directed stream of combustion air is introduced under ram pressure head at a point beyond the ignition head. It is to be anticipated then that combustion will not be complete within the head.

As already stated, owing to the effective leanness of the mixture, an optimum position of the gap is one directly in the nozzle spray somewhat removed from the nozzle so that it is exposed to a fuel spray which is more nearly atomized. This does, however, place the spark out in the combustion-air stream where there is a strong tendency for the spark to be blown out. The high-voltage high-energy spark described has proved sufficiently stable to withstand the air stream.

A consequence of introducing the spark-plug insulator and ground electrode well into the combustion chamber is the creation of local turbulence behind the insulator post. One of the commonly observed phenomena of combustion is the strong tendency of flames to attach themselves to such an obstruction due to the lowered air velocity in the region.[14] As a result of the rich mixture, combustion is incomplete and heavy deposits may be formed on the electrode and head. The deposition is furthered by the fact that the plug body and electrode transmit a considerable amount of heat to the heavy metal head.

During the early stages of the investigation, it was reported to the laboratories of the authors' company that a flat head was advantageous, since the dead zone was thus eliminated. This type of head is shown in Fig. 7. A number of brief life tests were conducted with several permutations of the nozzle, combustion-air inlet and spark-plug positions. In each case, heavy deposits of carbon and inorganic materials were formed about the plug and ground electrode, as shown in Fig. 8. The deposit formed in each case behind the plug with respect to airflow direction. In explanation, it should be pointed out that the air enters tangentially, thus imparting a rotary motion to the flame. The simple flat head construction was, therefore, abandoned.

Operating characteristics were then studied with a combustion head of the type shown in Fig. 9. The results were altogether more satisfactory. Several factors contributed to achieving clean operation. These are discussed in turn.

*Spark-Plug Design.* As already indicated, customary engine-cylinder practice requires cool plugs to minimize predetonation.

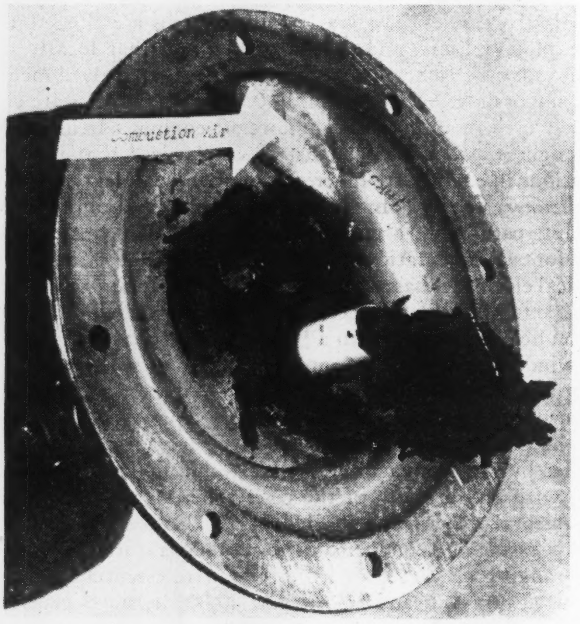

FIG. 8 EXPERIMENTAL FLAT HEAD AFTER 9 HOURS OF OPERATION, SHOWING SERIOUS DEPOSITION OF COMBUSTION PRODUCTS

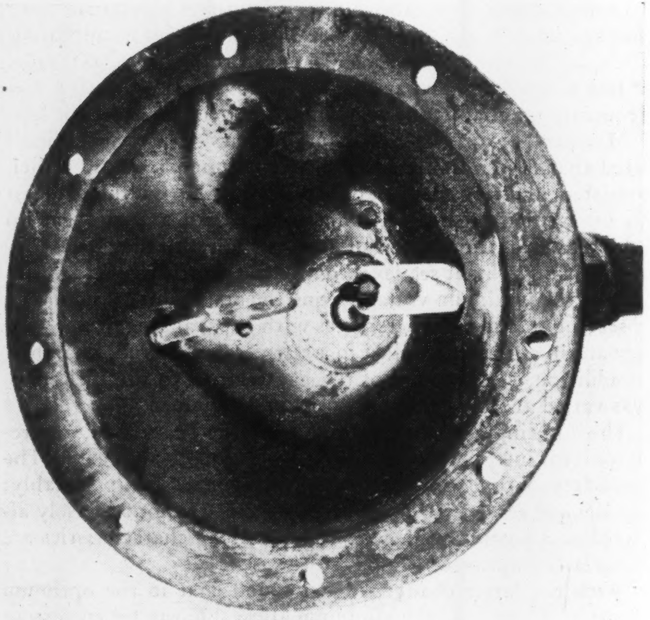

FIG. 9 EXPERIMENTAL IGNITION HEAD OF FINAL TYPE

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[14] Mache, "Die Physik der Verbrennungserscheinungen," described by Lewis and von Elbe.[9]

High-nickel-content alloy wire is therefore employed because of its relatively high thermal conductivity. Nickel-alloy wire is undesirable in the present case because a hot plug is preferable, and because nickel is subject to erosion under exposure to tetra-ethyl. A roughened eroded surface promotes adhesion of carbon; further, if the surface is cool, carbon tends to deposit. For this reason, high-chromium low-nickel-content alloys, such as Chromel D or 25–12 stainless-steel welding rod, have been used. These have low thermal conductivity and are erosion-resistant.

The shape and ceramic employed for the plug should be such that little heat is conducted from the flame. The ceramic material therefore must be thermal-shock-resistant. In addition, it must have high dielectric strength, and it must be resistant to chemical attack by gasoline additives, since erosion of the ceramic also promotes deposition. It was found, for example, that one of the porcelain glazes frequently used on plug bodies contributed to the vitrification of lead and sulphur compounds. Aluminum-oxide ceramics recommended by the Champion Spark Plug Company have been found most satisfactory.

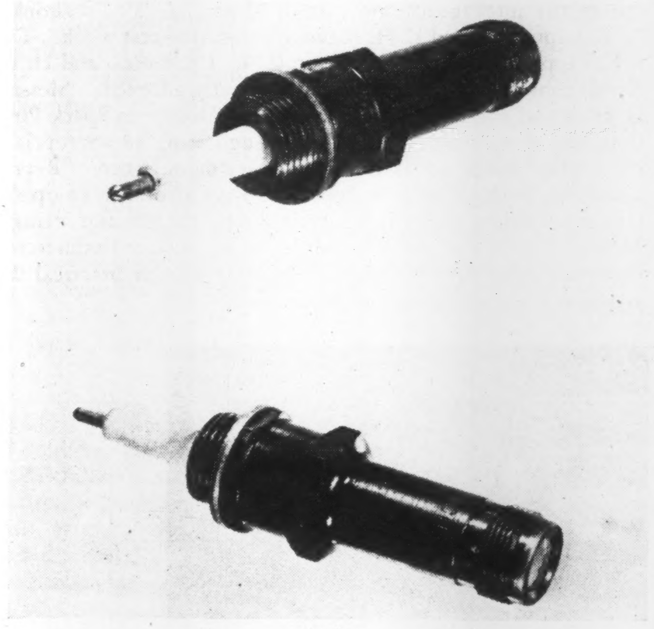

FIG. 10 SPECIAL-PURPOSE SPARK PLUGS USED FOR IGNITION HEAD

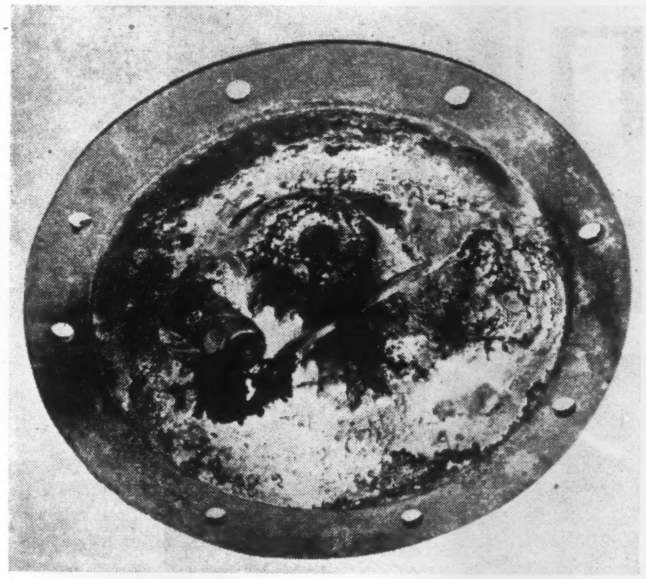

FIG. 11 EXPERIMENTAL IGNITION HEAD AFTER 181 HOURS OF USE
(The carbon bridge across the gap prevented further operation.)

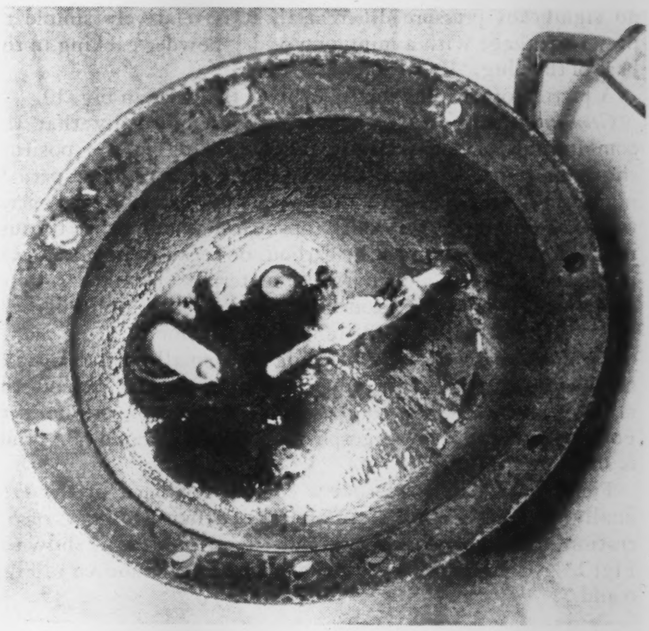

FIG. 12 HEAD SIMILAR TO THAT IN FIG. 11, WITH AIR BLEED NEAR NOZZLE ADDED, AFTER 534 HOURS OF USE
(The head was still operable.)

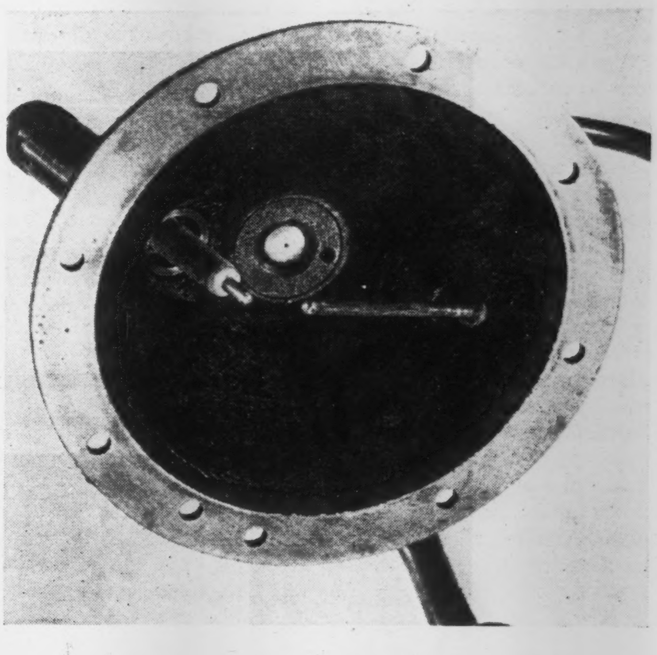

FIG. 13 FINAL IGNITION HEAD SHOWING SPARK PLUG, GROUND ELECTRODE, FUEL NOZZLE, AND AIR BLEED

In order to prevent cracks in the ceramic body due to differential expansion between the electrode and ceramic, the fit between the electrode and ceramic body is purposely made loose, having several thousandths clearance. Further, the electrode is not cemented to the body. Such design procedure would, of course, not be permissible with engine plugs because of the necessity for preventing leaks arising from the pressure differential across the plug. In the present case, since there is no significant pressure differential, it is relatively simple to prevent leakage with a minimum of dry-powder packing in the base of the plug.

A picture of the plug finally evolved is shown in Fig. 10.

*Geometry of the Head.* It was found empirically that the combination of the specially designed plug in the position shown in Fig. 11 resulted in satisfactory operation for periods ranging between 100 and 200 hr. In some cases, longer operation was obtained; generally, operation ceased either because the electrode was bridged by carbon, or because the nozzle was plugged by carbon and inorganic materials (lead and sulphur compounds) resulting from combustion. The photograph, Fig. 11, was taken after 181 hours of operation.

*Air Supply to Head.* By bleeding off a small portion of inlet combustion air and injecting it into the head around the nozzle, much cleaner combustion operation was obtained. For comparison a photograph of a head operated 534 hours is shown in Fig. 12.

Field reports indicate that a combustion head of the type finally evolved is quite clean after more than 900 hours of operation. A photograph of the final ignition head is shown in Fig. 13. Compare this with the original heads shown in Figs. 6 and 7.

## RADIO NOISE SUPPRESSION

The use of relatively high-voltage high-energy sparks presented some special problems in radio noise-interference suppression. The customary aircraft-engine practice of enclosing the high-tension lead in a flexible conduit satisfactorily reduces radiation from the cable. In order that the combustion chamber and ignition head present a continuous low-resistance path to radio-frequency currents induced in the shell, the use of conducting gaskets between the head and combustion chamber is required. Several radio-frequency filters are inserted between the power input and the vibrator and ignition coil to prevent high-frequency energy from being fed back into the airplane wiring system from which it could be radiated. As an additional and necessary precaution, the whole ignition system is enclosed in a double aluminum box to prevent direct radiation.

In summary, by applying somewhat more than usual care, a design has been obtained which successfully meets existing noise-limit specifications.

A photograph of an ignition box and attached shielded cable is shown in Fig. 14.

## ACKNOWLEDGMENTS

A large measure of the success of the program described is due to the intelligence and care of Messrs. J. W. Berghouse, N. E. Lapworth, and E. H. Meyer in executing test work. Dr. J. E. Lipp, Messrs. W. W. Reaser, C. W. Chambers, and H. E. North contributed many of the ideas finally adopted. Messrs. H. H. Vogel and R. W. Fredericks of the Champion Spark Plug Company were most co-operative in suggesting an appropriate spark-plug design and arranging for its manufacture. Representatives of the Titeflex Corporation were also most co-operative in providing specially designed shielded cables and fittings. Messrs. Lee Curtin and Wm. Myler of the Surface Combustion Company were very helpful in considerations of practical design and in getting units into production.

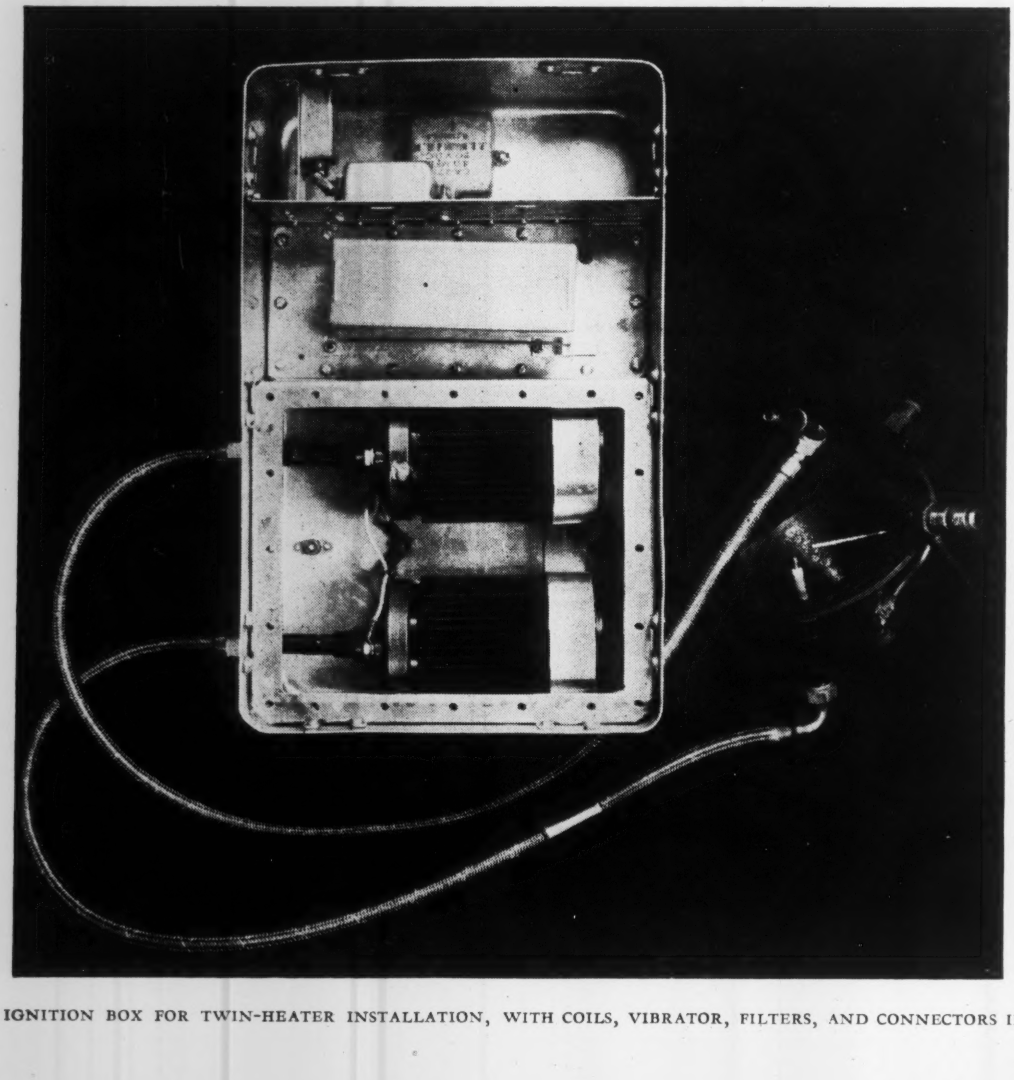

FIG. 14 IGNITION BOX FOR TWIN-HEATER INSTALLATION, WITH COILS, VIBRATOR, FILTERS, AND CONNECTORS INSTALLED

# A VIBRATION INVESTIGATION

By LLOYD E. MULLER

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IN testing experimental motorcars, both in the laboratory and on the road, slight relationship could be established between the static strength of the car and the "feel" of the car on the road. A car would appear to be very strong when tested statically in the laboratory and yet would have all of the characteristics of a "bowl of jelly" when driven on the road.

This discrepancy was disconcerting to say the least. Then to add to the embarrassment, the corrective for the trouble was usually not the addition of I-beams to the frame, but some minor change in the motor mount. While these experimental cars always attained the state of acceptability before the production dead-line date had been reached, they did cause headaches. Even after the cure had been effected, we did not know why; and the cure did not always work in the case of the next model car upon which it was tried.

It was then decided to investigate the vibrational and dynamic strength characteristics of experimental cars and to establish the relationship of actual car strength to apparent car strength.

It is the purpose of this paper to present a discussion of the tests conducted and some of the results obtained.

In the final analysis all strength is relative. This statement is aptly illustrated by the following. Some place in engineering history, the story is told of a certain bridge that had been used for years with no signs of weakness although there had been continual heavy traffic over it. Then, while a column of soldiers were marching over the bridge, it collapsed. The question arose as to why the bridge failed and, upon investigation, it was determined that the rhythmic steps of marching men, synchronizing with the natural frequency of the bridge, had destroyed it. Military books now carry instructions for soldiers to break step while crossing bridges.

### DESIGNING CARS FOR ROAD SHOCKS

Therefore, if our assumption is correct, we could design the frame and body for road shocks and road loads only and not for vibrational fatigue and should be able to effect a substantial saving in weight and cost.

As the first step in this investigation, six cars were selected which had road characteristics ranging from the "jelly" type to solid-feeling type. These cars were selected regardless of make, wheel base, frame type, etc. Strength checks were then made on these cars, the results obtained being given in Table 1.

TABLE 1 STRENGTH TESTS ON TYPICAL MOTORCARS

| Strength tests | Road impression |
|---|---|
| Car A | Car E |
| Car B | Car A |
| Car C | Car F |
| Car D | Car C |
| Car E | Car D |
| Car F | Car B |

—Weakest–Strongest—

—Poorest–Best—

In the tabulation, under "road impression," the cars are listed according to their feel on the road with the first car E being the best, and car B the poorest.

Likewise, under "strength tests," the cars are listed according to their strength with car A being the strongest and car F the weakest.

As will be seen from Table 1, the feel of the cars is in almost the reverse order as compared to their strength. These data were considered of sufficient importance to warrant a full investigation.

The problem was then divided into two major classifications, namely, "static strength" and "vibrational or dynamic strength."

While we were convinced that static strength was not the final answer to the problem, we did not feel qualified to undertake the dynamic problem until we knew which members were the primary strength-contributing factors, and in what proportion they affected the over-all strength of the car.

### SETUPS FOR STATIC TESTING

The test setups shown in Figs. 1, 3, and 5 were used. Fig. 1 shows the method used in testing for torsional strength. The frame was held rigidly at the rear spring seats and flexibly by means of a chain on the center line of the frame at the front end. The torsional load was applied by means of the bar *A* and the weight *B*. The deflection was recorded at various points along both sides of the frame by means of dial indicators.

The resulting data give a deflection curve as shown in Fig. 2, where the abscissa is the distance from the center line of the front wheels and the ordinate is the deflection.

Fig. 3 shows the method of obtaining beam deflection. This test gives the curve shown in Fig. 4. The *X* shown is the deflection at the center of the *X* member of the frame. No attempt was made to join the points on the curve with a smooth curve.

Fig. 5 shows the method of obtaining side deflection. The frame was held at the four spring supports and loaded by means of a bell crank whose force was transmitted to the frame by the motor mounts. The application of the load, through the motor and motor mounts, was used because of the fact that all rear-wheel road loads are transmitted to the chassis in this manner due to the torque-tube drive. Fig. 6 shows the resulting curve.

The body was then installed on the frame and held in place with production body bolts and rubber shims. The three tests, namely, torsion, beam, and side deflection, were then made and the effect of the body on the over-all strength is shown in Figs. 7, 8, and 9.

To illustrate the refinement of these tests, it can be stated that the difference in the over-all strength of the car can be measured, when the cloth top on the convertible car is up and when it is down.

In Fig. 10, it will be noticed that there was practically no difference in the strength of the car when the engine was installed.

Fig. 11, shows that the rubber shims, as used in production, do not decrease materially the over-all strength of the body-and-frame combination over solid-steel shims.

After completing the static tests our attention was then turned to the dynamic or vibrational tests.

### VIBRATIONAL TESTS CORRECTED

As the first attempt to excite the car vibrationally, the car was run on chassis rolls which had been equipped with bumps. However, it was soon learned that the problem was rather

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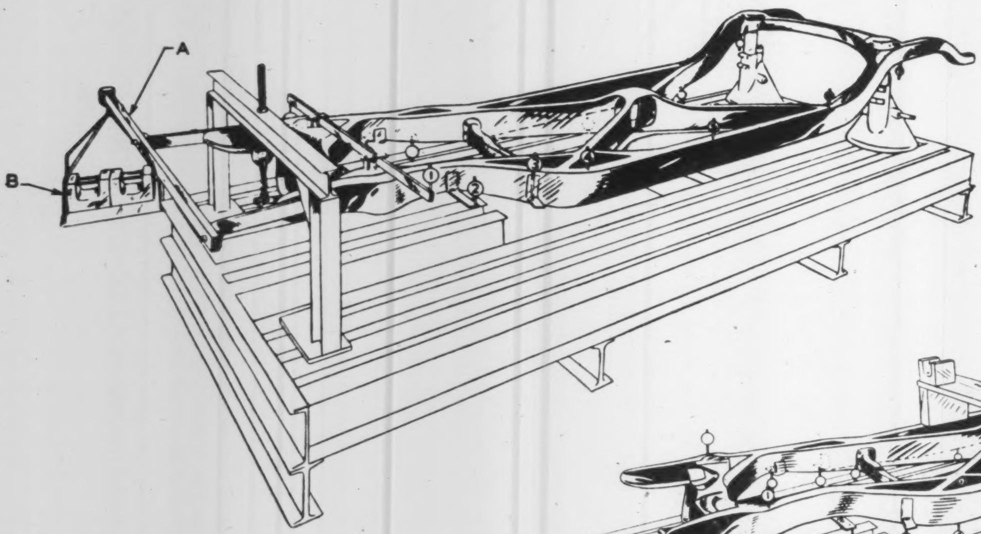


FIG. 1 TORSIONAL-STRENGTH TEST FIXTURE

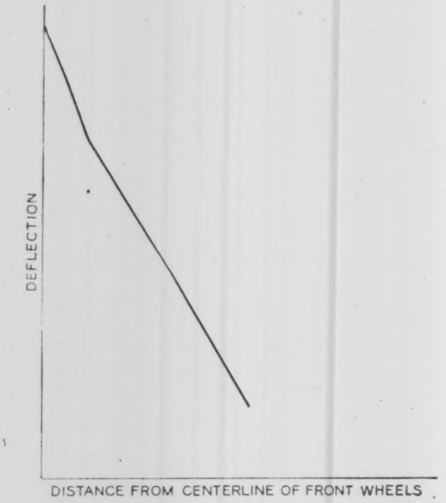


FIG. 2 TYPICAL FRAME TORSIONAL-DEFLECTION CURVE OBTAINED WHEN TESTED WITH FIXTURE SHOWN IN FIG. 1

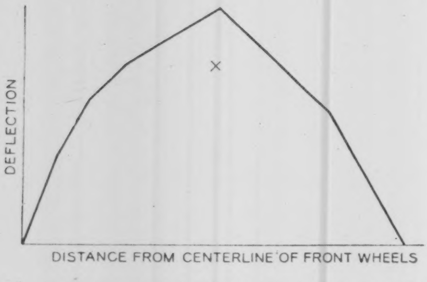


FIG. 4 TYPICAL FRAME BEAM-DEFLECION CURVE OBTAINED WHEN TESTED WITH FIXTURE SHOWN IN FIG. 3

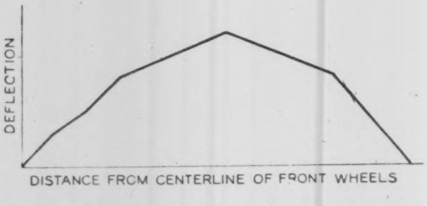


FIG. 6 TYPICAL FRAME SIDE-DEFLECTION CURVE OBTAINED WHEN TESTED WITH FIXTURE SHOWN IN FIG. 5

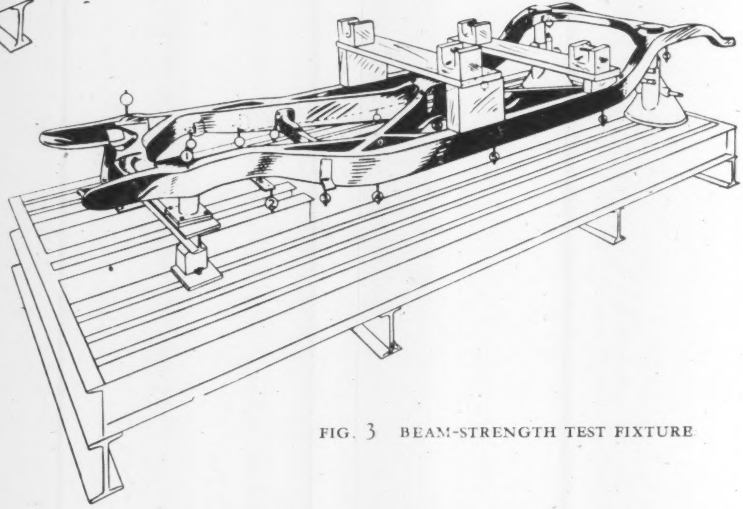


FIG. 3 BEAM-STRENGTH TEST FIXTURE

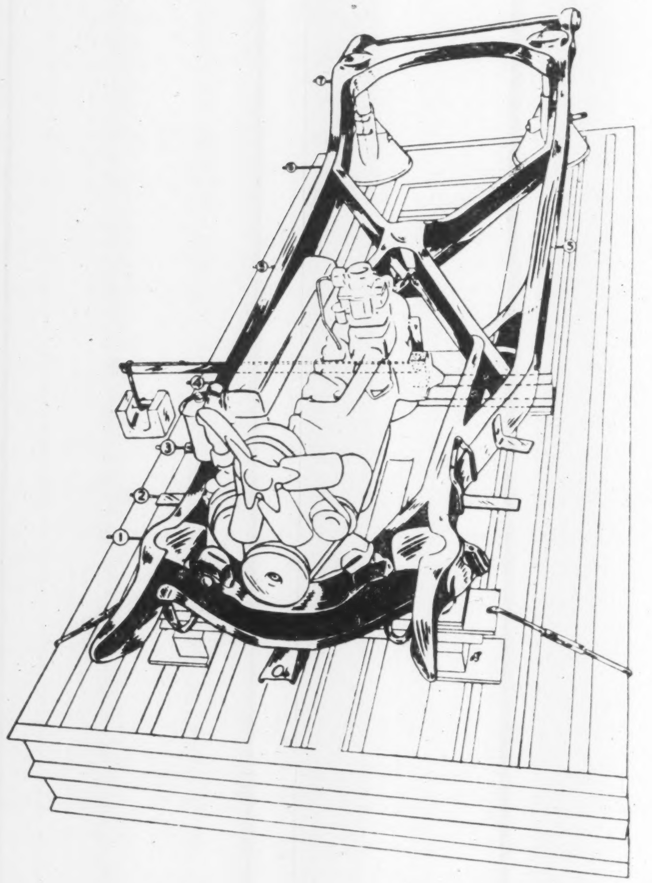


FIG. 5 SIDE-STRENGTH TEST FIXTURE

complicated and that a refresher course in Physics II was indicated. Therefore, tests were conducted on elementary spring-and-weight systems with the equipment shown in Fig. 12. A typical result is shown in Fig. 13.

From these simple tests, we felt qualified to recognize the various types of vibration to be encountered in the car and also had confidence in the formulas to be used. We therefore dismantled a car and obtained the weight of all units and necessary spring rates. This car had been driven for road impression, and static strength tests had been made on it. Hence we felt that the characteristics of this car were known from every angle, and that we could co-ordinate the data as collected into terms usable in both the laboratory and on the road.

One of the first and simplest uses made of the information gained with the elementary spring-and-weight equipment was the application of the two-spring and two-weight system to the rear axle of the car, as shown in Fig. 14.

In this application the tires and chassis springs are considered as the two springs and the axle assembly and the body-frame assembly are considered as the two weights. Road bumps are considered as the exciting force.

Exception may be taken by some to this application, since strictly speaking the motion of the rear end of the car is not a vertical motion but a curvilinear one. However, since the calculated frequencies approximate so closely the actual frequency, the method is used since it simplifies the calculations.

In order to visualize or co-ordinate these two resonant frequencies with the action of the car, it can be roughly assumed that the 79 cycles per min frequency is the up-down action of the car on the chassis spring, and the 535 cycles per min frequency is the hop frequency of the wheels. In fact, the lower frequency was checked by disconnecting the shock absorbers and bobbing the car on its chassis springs. The higher frequency was checked by driving the car over a "washboard" road at a speed that produced wheel hop. Then, from the speed of the car and the number of bumps that were traversed, the frequency was calculated.

Some explanation is necessary as to why so much time was spent in calculating something that was already known. The main thought behind the calculations was to ascertain what the controlling factors were and their relative importance. To

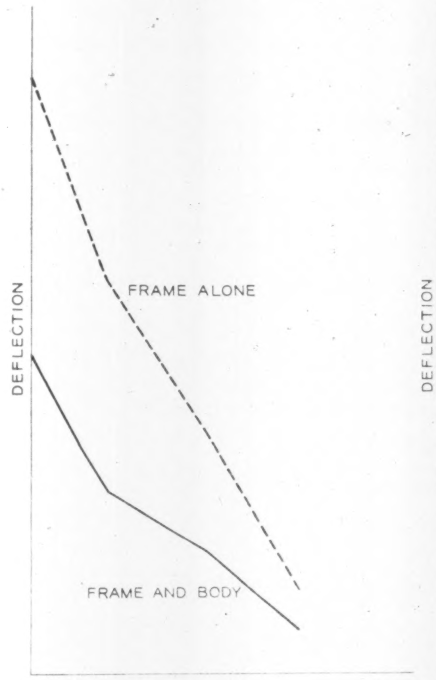


FIG. 7 CURVES SHOWING TORSIONAL STRENGTHENING EFFECT OF BODY

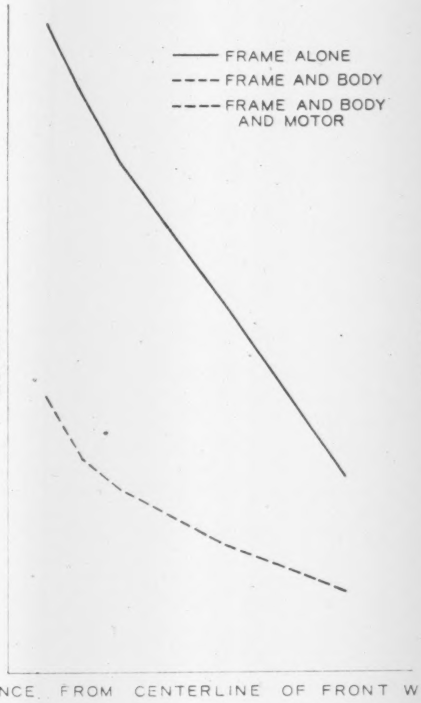


FIG. 10 CURVES SHOWING THAT MOTOR MOUNTS HAVE PRACTICALLY NO EFFECT ON OVER-ALL TORSIONAL STIFFNESS OF CAR

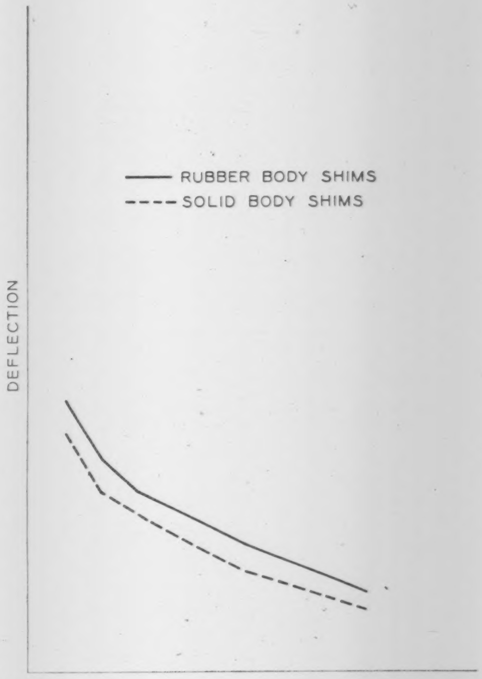


FIG. 11 CAR TORSIONAL STIFFNESS COMPARISON BETWEEN SOLID-STEEL BODY SHIMS AND RUBBER SHIMS

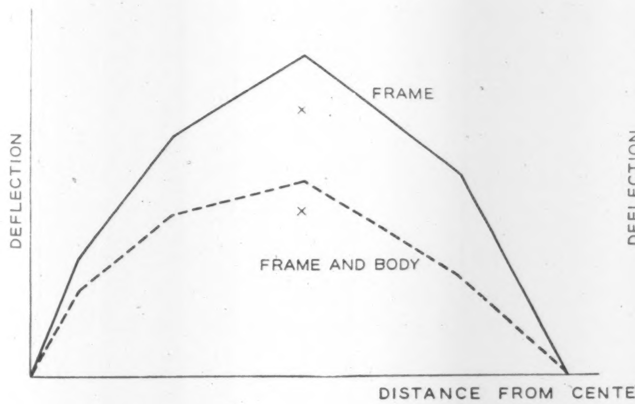


FIG. 8 CURVES SHOWING BEAM STRENGTHENING EFFECT OF BODY

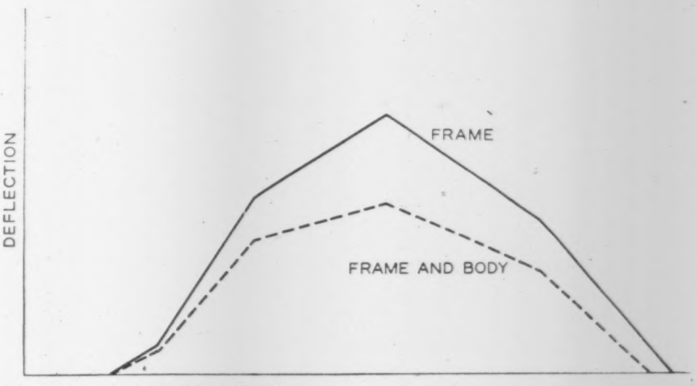


FIG. 9 CURVES SHOWING SIDE-DEFLECTION EFFECT OF BODY

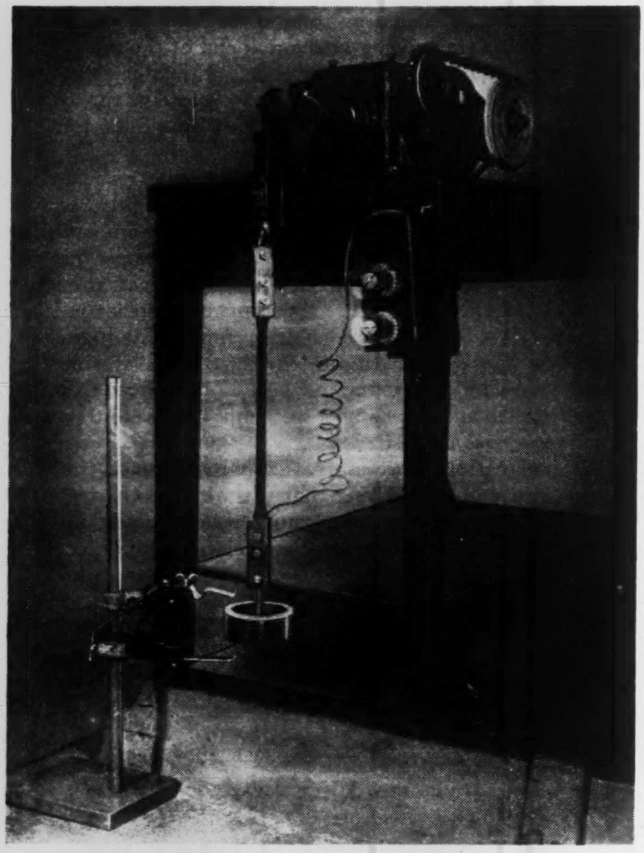


FIG. 12 ELEMENTARY SPRING-AND-WEIGHT-STUDY EQUIPMENT

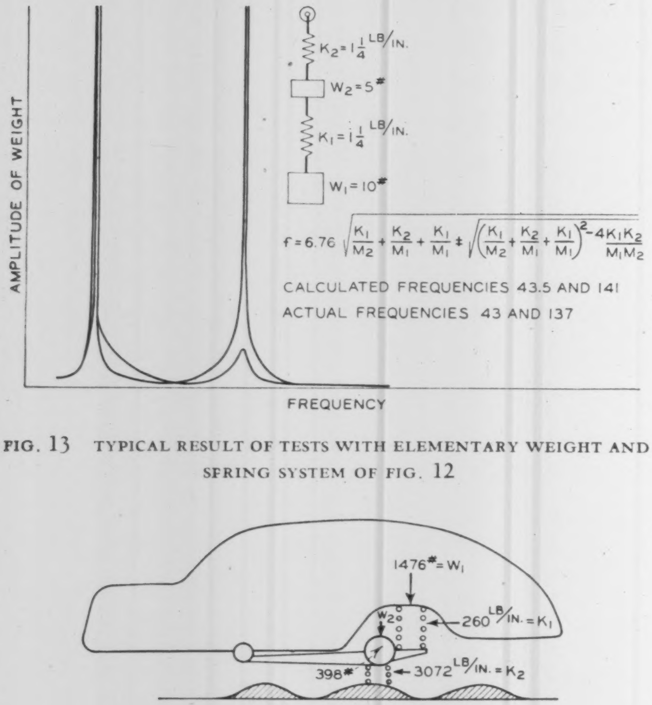
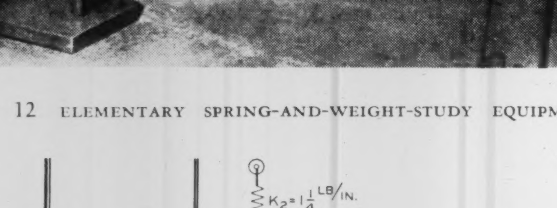


FIG. 13 TYPICAL RESULT OF TESTS WITH ELEMENTARY WEIGHT AND SPRING SYSTEM OF FIG. 12



$$f = 6.76\sqrt{\frac{260}{\frac{398}{386}}+\frac{3072}{\frac{398}{386}}\frac{260}{\frac{1476}{386}}+\sqrt{\left(\frac{260}{\frac{398}{386}}\ \frac{3072}{\frac{398}{386}}\ \frac{260}{\frac{1476}{386}}\right)^2-4\left(\frac{260\times 3072}{\frac{398}{386}\ \frac{1476}{386}}\right)}}$$

CALCULATED FREQUENCIES 76 CPM AND 544 CPM
ACTUAL FREQUENCIES 79 CPM AND 535 CPM

FIG. 14 APPLICATION OF ELEMENTARY SPRING-AND-WEIGHT STUDY TO CAR

accomplish this, there is probably no better or faster method than by examining a formula that is known to be correct.

This fact can be illustrated by supposing it was desirable to lower the hop frequency of the wheels by a considerable amount. If we did not know the formula that expressed this action and relied upon experimentation only, a great deal of time might be spent in testing a number of chassis springs having various rates. However, by using the mathematical approach, we find that the frequency of the wheel hop is lowered only 15 cycles per min, or from 535 to 520 cycles per min, if the spring is entirely removed. Obviously, the chassis spring is a very poor place to work.

### EFFECT OF MOTOR MOUNTINGS

Naturally in this work motor mountings received a great deal of consideration. Since this was to be an investigation to learn something of the importance of vibration, and since the engine contains considerable mass and is certainly suspended in such a way as to produce vibrations, we therefore approached the mounting problem as though we had never heard of nor seen a motor mount before. It was decided to explore the complete range of motor-mount stiffness, so as a start, a set of all-steel mounts was made and tried. Then by steps the rate of the mounts was decreased, by adding rubber, until the fantastic static deflection of 2 in. was reached. The next step was to determine the best location for the mounts and the proper rates in the various planes in which they are called upon to function.

In vibration work, two factors are involved, namely, frequency and damping. In ride work these factors are recognized and used. The springs control the frequency of the ride, while the shock absorbers and the interspring friction control the damping or amplitude of the ride. However, in motor-mounting applications, most of the effort has been expended on the frequency aspect of the problem and very little on the damping phase. Until recently, this approach has been both proper and correct because of the cost and the inconvenience of the method of providing the necessary friction. However, as previously stated, since this was to be a complete investigation of vibration, it did not seem proper to ignore the possibilities of damping to help give the car the proper "feel" on the road. As a result, considerable work has been done to determine the correct amount of friction to be used in the motor mounts.

### DAMPING PRINCIPLES APPLIED

As will be recalled, if no damping is present in a vibrating system which is being excited at its resonant frequency, that system will gain in amplitude of movement until some member fails. However, if damping is present in a sufficient amount, the amplitude will be controlled below the breaking point of the various parts. This is illustrated in Fig. 15. The solid line represents the amplitude of the weight with no friction, and the dotted lines with various amounts of friction. It will be noted that, with no friction, the amplitude of the weight is infinite, and with friction the amplitude is a finite and measurable amount.

In this investigation a number of types of friction were tried, as follows:

1 Dash pots.
2 Shock absorbers.
3 Friction devices having higher breakaway friction than running friction.
4 Friction devices having equal breakaway friction and running friction.
5 Rubber (synthetic) having hysteresis.

Obviously, now that synthetic rubber is available and we are learning to use it, it is the most practical method of gaining friction, provided it can be controlled and does not introduce other objectionable qualities.

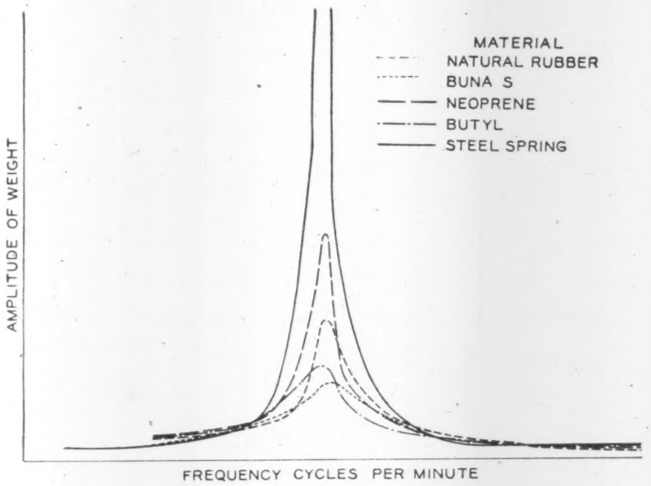


FIG. 15 DAMPING EFFECT OF VARIOUS TYPES OF MATERIALS

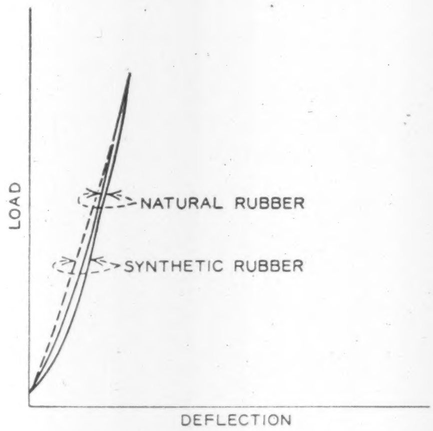


FIG. 16 STATIC COMPRESSION HYSTERESIS COMPARISON BETWEEN NATURAL AND SYNTHETIC RUBBER

(Durometer hardness same in both types of rubber.)

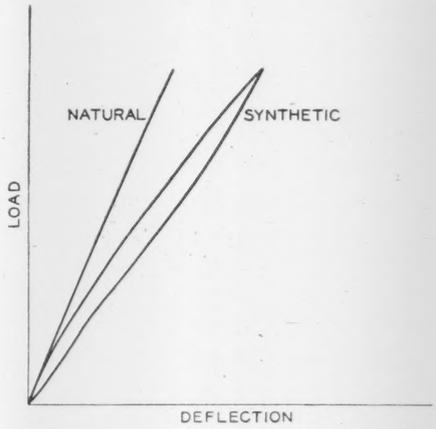


FIG. 17 STATIC SHEAR HYSTERESIS COMPARISON BETWEEN NATURAL AND SYNTHETIC RUBBER

(Durometer hardness same in both types of rubber.)

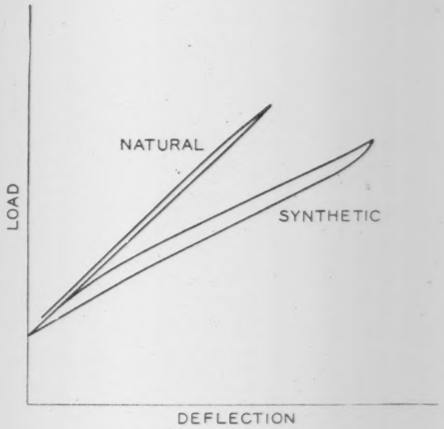


FIG. 18 STATIC SIDE-SHEAR HYSTERESIS COMPARISON BETWEEN NATURAL AND SYNTHETIC RUBBER

(Durometer hardness same in both types of rubber.)

Figs. 16, 17, and 18 show the difference in hysteresis between two identical mountings, except that one was made with natural rubber and the other with synthetic rubber.

The three curves are for static shear, side shear, and compression loading, respectively, and were obtained on an Olsen type of tensile machine. However, we were not satisfied that these curves were indicative of the true conditions encountered under actual operating conditions since they were made at room temperature and required about 15 min for 1 cycle while, under actual conditions, 1000 cycles per min may be made.

To obtain data which would represent the true facts, the machine shown in Fig. 19 was built. This machine will test the actual mounting to be used and will give the hysteresis, temperature rise, work input, rate, and life expectancy of the mount at the frequency it is to be used.

The machine provides for variable frequency, preload, ambient-air temperature, and stroke or amplitude. It is rugged enough to withstand continuous running called for in endurance work and can be used for production-control work.

###### METHOD OF TESTING ENGINE MOUNTS

The mounting to be tested is bolted in place at *A* and is preloaded by means of screw *B*. At point *C* a double eccentric is provided in the connecting rod so that the stroke may be altered. The electronically controlled variable-speed motor at *D* provides the desired frequency and will hold at least within plus or minus 2 rpm of the desired speed after it is once set. The ambient-air temperature is controlled either by putting the whole machine in a cold room for low temperatures or covering the mounting with a heating box for elevated temperatures. Mounting temperature is recorded by means of a thermocouple.

The hysteresis is measured by means of a wire strain gage cemented to tube *E*, the electrical current being transmitted through a suitable amplifier to the oscillograph where it is recorded on a calibrated scale. Fig. 20 shows a typical loop obtained.

###### REDUCING NOISE LEVEL IN MOTORCARS

We hear because of vibrations. Therefore, if we eliminate vibrations, a quiet car will be produced. Four methods are available to accomplish this objective, namely, (1) to build a structure so rigid it will not vibrate or vibrate at a frequency so high as to be inaudible; (2) to eliminate the exciting force; (3) to unsynchronize the natural vibration periods of all parts; (4) to absorb vibration if it occurs. Naturally, it is physically impossible to accomplish any single one of these objectives but by working along each path, until the law of diminishing returns indicates the commercial limit has been reached, a highly satisfactory noise level should be reached. One step in this direction was the development of the body shims now used in production.

Since the method used in bolting the body to the frame affects the sound qualities as well as the strength qualities of the car, a noise-reduction program was carried along as one phase of the vibration-reduction endeavor.

It was established quite early in the program that the human ear is not a good instrument for measuring sound. This is due to the fact that in some cases the changes to be made were of such a nature as to involve considerable time, and, since the ear does not give a permanent record, the original impression would be lost. A sound-and-vibration-level recorder was procured to give this record.

A second contributing factor to error in judgment of the noise level was the ever-changing road conditions resulting from ice, snow, etc. To obviate this, a plaster cast was made of a gravel road at the General Motors Proving Grounds where most road-noise work is done. From this pattern, cast-aluminum plates were made to fit test rolls. A set was also made to duplicate brick-road conditions.

To prove that no basic discrepancy had occurred, tests were conducted with the noise meter on the rolls and over the same

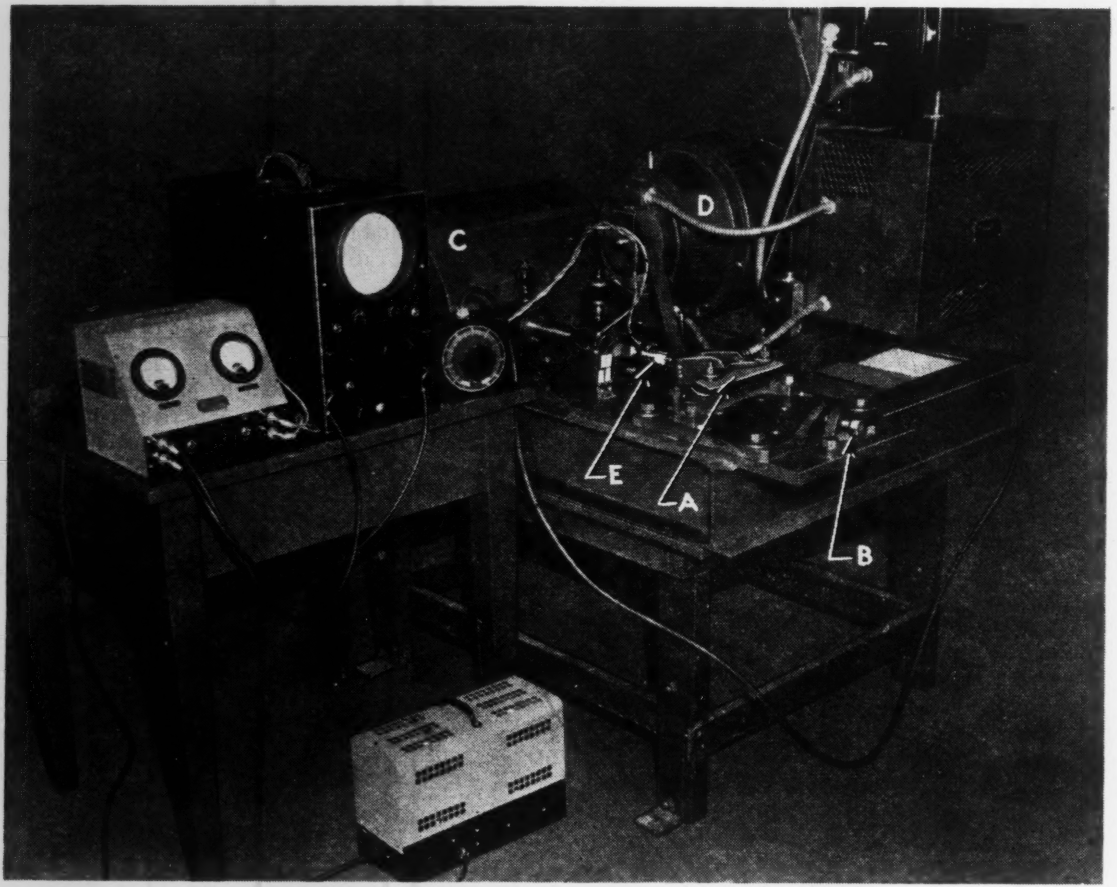


FIG. 19 EQUIPMENT USED TO OBTAIN ENDURANCE AND HYSTERESIS DATA ON MOTOR MOUNTINGS

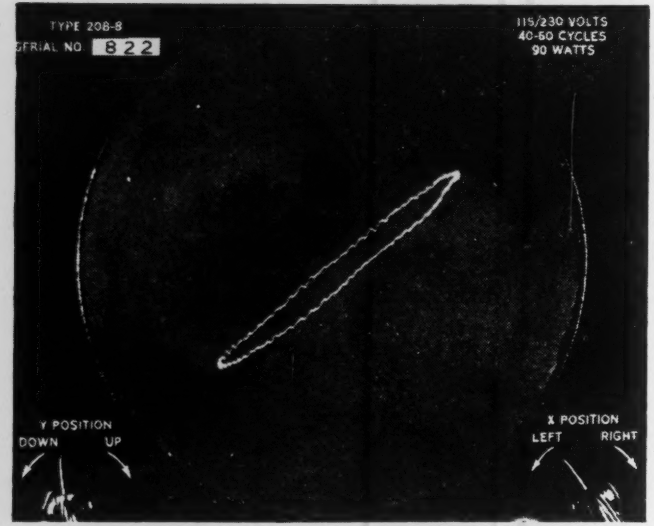


FIG. 20 HYSTERESIS LOOP OBTAINED ON CATHODE-RAY OSCILLOGRAPH

road from which the casts had been made, a very close agreement being obtained.

With this noise equipment and strength-test data, a satisfactory type of body-bolt insulation was developed and used in production. This type of insulation, which is shown in Fig. 21, gives good noise- or vibration-insulating qualities and realizes practically the full available strength of the frame and body. It also gives a predetermined preloading of the rubber and allows the body to be leveled without affecting this preload.

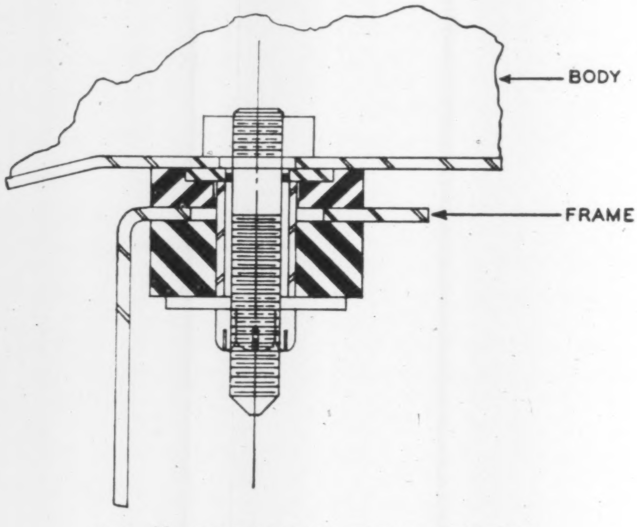


FIG. 21 BODY-BOLT INSULATION NOW USED

## CONCLUSION

The war started about the time we were commencing to realize some of the benefits of this investigation. However, a substantial weight reduction has been made in some of the frames used, and the Road Test Department reported a much better "road feel" to the cars. Also, satisfactory motor mounts were developed which completely eliminated torque reaction.

Reductions of as much as 10 decibels in road noise have been made when using the equipment and suggestions outlined. The body shims developed have proved very satisfactory in service.

# STANDARDIZATION TOMORROW?

## *What the Aircraft Industry Has Accomplished and a Plea for Co-Operation Throughout Industry in the Future*

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ENGINEERING management, particularly in the aircraft industry, is urged to lend more active support to the general trend toward standardization. In this paper examples are given indicating the extent of the improvement in product quality and the cash dividends which have accrued through standardization. Certain important developments in standardization work are noted and suggestions are given which should make efforts in this direction more effective in the future.

### LOW ESTATE OF STANDARDS ENGINEERS

Too often in a busy engineering department, overloaded with design work, standards engineers are just tolerated or considered overhead, necessary perhaps but not productive in so far as getting on with the main job is concerned. As for having responsible design engineers spend time on standards work—that is just too much even to consider. When pressed, engineering executives will generally agree that standardization has some value but that the benefits are too intangible and too far in the future to warrant more than a low priority for standards work in comparison with today's urgent tasks.

If standardization is as important as many who have studied the problem feel, who is responsible for the too general attitude toward it among our operating managements? In considerable part it is felt that the responsibility lies squarely on the doorstep of the standards organization and to a lesser extent of the standards engineer. Because of absorption in their technical and organizational work, they have quite neglected the public-relations function, which is so uniquely important in standardization. The burden of proof that this function may be a highly profitable investment, paying handsome dividends, and recurring ones, is up to those backing it. It must not be overlooked that these dividends are often in the form of enhanced quality of product, frequently not obtainable any other way. Discussion and generalities have their value, but in this campaign specific facts and figures are needed to convince. Sporadic efforts to present the case are not effective. They must be repetitive and carefully planned with attention given to the manner of presentation. Above all they should be directed toward business and engineering executives—not standards engineers or the general public. Publicity should stress not only the positive side, namely, the gains and achievements, but also the negative side; the frequent high costs, inefficiencies, and inadequate technical quality due to lack of standardization.

### EXAMPLES OF STANDARDIZATION WHICH PAID DIVIDENDS

In this section of the paper a few examples will be presented, some from experience of the author's company, others contributed by engineers from other companies.

*High-Strength Internal Wrenching Bolt.* The story of the high-strength internal wrenching bolt, Fig. 1, as used on the Douglas C-54 makes a good beginning. These bolts were originally of Douglas design to conserve weight and space. Table 1 summarizes the price picture before and after standardization. The extraordinary decrease in cost is due largely to more efficient manufacturing methods and the greatly increased production because of wide usage resulting from standardization. During that process, design changes produced a stronger and lighter bolt, the weight saving amounting to 8 lb per airplane in the case of the C-54.

TABLE 1 INTERNAL WRENCHING BOLTS

(Used on the Douglas C-54)

| Diameter, in. | Bolts per airplane | Cost per airplane: Douglas design | Cost per airplane: NASC[a] standard | Saving per airplane |
|---|---|---|---|---|
| $^{1}/_{4}$ and $^{5}/_{16}$ | 39 | \$ 49.70 | \$ 8.34 | \$ 41.36 |
| $^{3}/_{8}$ and $^{7}/_{16}$ | 56 | 91.49 | 16.77 | 74.72 |
| $^{1}/_{2}$ | 96 | 166.00 | 44.00 | 122.00 |
| $^{5}/_{8}$, $^{3}/_{4}$, and 1 | 26 | 51.44 | 20.78 | 30.66 |
| Total | 217 | \$358.63 | \$89.89 | \$268.74 |

[a] National Aircraft Standards Council (NASC).

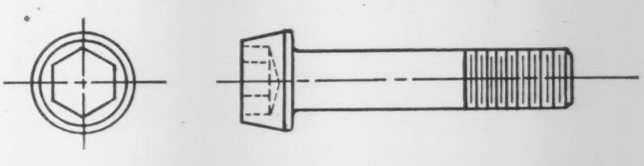

FIG. 1 INTERNAL WRENCHING BOLT

The cost savings approximate well over \$600,000 for the total contracts involved. Without national standardization there would undoubtedly have been some reduction from the prices paid for the Douglas bolts but nothing comparable to the savings shown. That standardization of a single class of parts on one type of airplane only should have such an economic effect is startling.

*Aircraft Ball-Bearing Pulley.* The next example is of unusual interest for other reasons: (1) Because it is an item used for years by the millions without critical thought; (2) because the standardization has as its objective improved functional quality, cost reduction being a by-product; and (3) because the man who initiated and is conducting the work is not a standards engineer but R. R. Richolt, hydraulic and mechanical staff engineer for Lockheed.

The article which offended Mr. Richolt's sense of design fitness so that he finally decided to do something drastic was the aircraft ball-bearing pulley. The development of over 300 special pulleys in current use, similar to the AN210 series, came about as the result of the latter's inadequacies.

In working up the design of the proposed NASC series, Fig. 2, the subcommittee first made an analysis of the functional and design requirements. The basic change is in the pulley capacity ratings which are based on the "limit" load in the airplane cable system. The resultant pulley load, with a safety factor of 2, and the allowable bearing stress of the sheave material determine the sheave design. With the AN (Army-Navy) series, only the bearing was protected by the rated capacity and

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Presented at the Aviation War Conference, Los Angeles, Calif., June 11–14, 1945, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

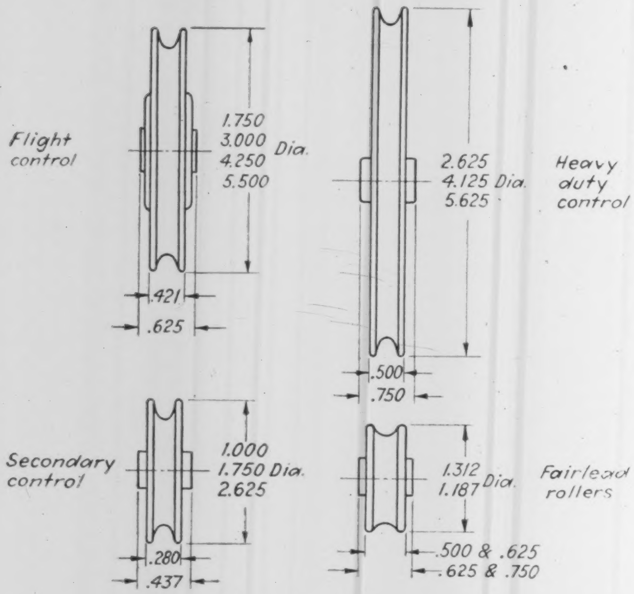


FIG. 2 PROPOSED NASC PULLEY STANDARDS

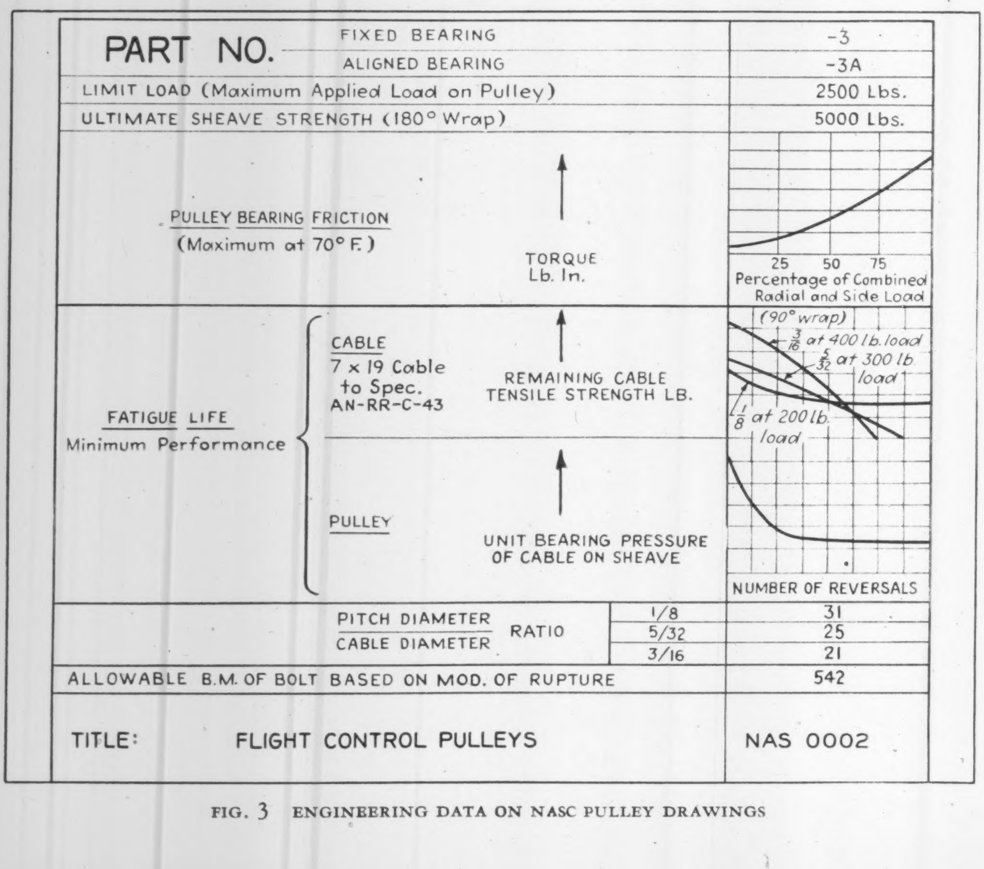
the sheave could be so overloaded as to cause early failure. To aid the designer in intelligent selection of a pulley for a specific application, with due regard for pulley and cable life, the NASC standard drawings will contain two S-N curves, one for the sheave and one for the cable, Fig. 3.

The bearings will be specially designed to meet pulley requirements. The hubs will project sufficiently to provide adequate clearance and will be wide enough to permit a double-row ball or needle bearing that will be much lighter and give more stability than the present single row. An important feature of the secondary-control pulleys for engine controls is provision, in two sizes, of a 0.625-in. bore to permit gang mounting on a tube. The proposal also includes pulleys capable of being aligned within 2-deg limits and locked, primarily for prototype and early-production airplanes. The more efficient pulley design possible when definite performance specifications are furnished makes possible a weight saving on flying-control pulleys of about 40 per cent.

Because it shows so clearly why a properly developed modern standard excels from both a quality performance and production viewpoint, a summary is given of the development of the NASC pulley. The initial proposal was prepared by Mr. Richolt and a representative of a bearing manufacturer; this was presented to the NASC controls subcommittee and their suggestions incorporated; a design-policy questionnaire was sent to all aircraft companies for comment; then a conference was called of twelve leading pulley and bearing manufacturers, and their experienced representatives, working with two aircraft engineers, studied it in detail and made recommendations; a special panel representing the three groups concerned was chosen to draft the final design envelope and performance requirements; these have now been submitted to all aircraft companies for final comment and approval.

Once the pulley and bearing manufacturers understood that the proposal was for postwar manufacture and would not upset war production, they were heartily in favor of it as they have experienced difficulties under present conditions and do not relish manufacturing 300 special pulleys. Under the proposal, 20 pulleys cover all requirements, including those for heavy-duty and fair-lead pulleys, and will not have to be supplemented except in minor degree. Their cost will be about the same as for AN210 pulleys. A large cost saving, however, will occur as a result of elimination of the "specials."

*Hydraulic Fittings.* In complete contrast to the preceding example is the case of standardization of the AC811 series of hydraulic fittings, Fig. 4. For new design and some current models, this series was superseded by a new series of AN fittings, but for several airplanes in large production no change was made. The AC811 series was originally proprietary and made by one manufacturer. However, procurement demands were so great that several sources had to be developed. One dif



| | | |
|---|---|---|
| PART NO. | FIXED BEARING | -3 |
| | ALIGNED BEARING | -3A |
| LIMIT LOAD (Maximum Applied Load on Pulley) | | 2500 Lbs. |
| ULTIMATE SHEAVE STRENGTH (180° Wrap) | | 5000 Lbs. |
| PULLEY BEARING FRICTION (Maximum at 70° F.) | TORQUE Lb. In. | |
| FATIGUE LIFE Minimum Performance: CABLE 7 x 19 Cable to Spec. AN-RR-C-43 | REMAINING CABLE TENSILE STRENGTH LB. | |
| FATIGUE LIFE Minimum Performance: PULLEY | UNIT BEARING PRESSURE OF CABLE ON SHEAVE | |
| PITCH DIAMETER / CABLE DIAMETER RATIO | 1/8 | 31 |
| | 5/32 | 25 |
| | 3/16 | 21 |
| ALLOWABLE B.M. OF BOLT BASED ON MOD. OF RUPTURE | | 542 |
| TITLE: | FLIGHT CONTROL PULLEYS | NAS 0002 |

FIG. 3 ENGINEERING DATA ON NASC PULLEY DRAWINGS

ficulty was that the available drawings, as released by the Army, were not completely dimensioned; critical dimensions were specified by calling out a tool number. Much confusion arose in interpreting these drawings, and supposedly identical parts produced by different vendors differed.

Finally the Lockheed Company sponsored an NASC project for the preparation of a set of standard drawings. Slight changes in design and in tolerances made it possible to machine the fittings with standard tools on automatic equipment, saving considerable tooling and manufacturing time. The NASC proposal was presented to the Services and resulted in issuance of WPD Directive 6-W-2. Large cost reductions resulted, as shown in the case of typical parts itemized in Table 2.

TABLE 2 AC811 STRAIGHT CONNECTOR FITTINGS

| Part no. | Price based on: Original drawings | Price based on: NASC drawings | Reduction, per cent |
|---|---|---|---|
| HT 12 D | $0.57 | $0.26 | 54.5 |
| HT 4 D | 0.114 | 0.087 | 23.5 |
| CT 5 | 0.22 | 0.128 | 42.0 |
| HT 8 6D | 0.36 | 0.20 | 44.5 |
| HT 6 D | 0.231 | 0.10 | 56.5 |

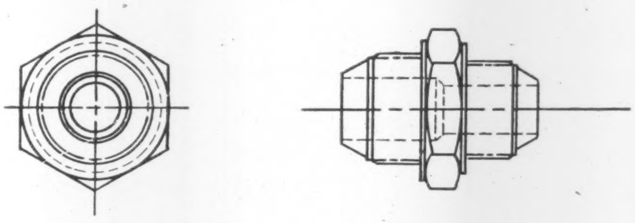


FIG. 4 AC811 STRAIGHT CONNECTOR FITTING

In 1944 the Lockheed Company, as a result of this work, saved $406,000 over previous prices and greatly facilitated its procurement. In this instance, standardization did not change functional quality but powerfully affected economic efficiency.

*Fuel-Cell Fittings*. The next illustration, contributed by North American Aircraft Corporation, is typical of extremely useful standards work and is of great interest because it demonstrates the considerable savings in engineering design time, which frequently result from standardization. It is the design of a set of standard self-sealing fuel-cell fittings, undertaken by the Air Technical Service Command in co-operation with the major rubber companies. These cover various sizes of single- and two-plane fittings from which an engineer can select in designing a fuel cell.

Prior to the advent of these standards, a choice might be made either from a multitude of existing fittings, if drawings were on hand, or a new fitting drawn up. In general, molds for existing fittings were available to only one or two vendors. If an order were placed elsewhere, the cost of new tooling and a procurement delay of 3 months or more were involved. Now, each vendor has molds for all standard fittings. Thus this standardization project has the following advantages:

1 Provides a set of standard fittings from which an engineer can choose, eliminating investigation into available nonstandard types, except in unusual cases.

2 Eliminates the necessity for detailing fittings with each cell. In a typical case, 48 drawings and 500 engineering hours were required for such drawings for one new tank.

3 Reduces procurement time and cost.

*Surface Finish*. The NASC project for the development of standards to designate surface finish would appear to be of the somewhat theoretical type with the practical benefit rather long range and a bit hazy. Judging from the recent experience of North American Aircraft Corporation (NAAC) quite the contrary is true. The benefits have been most tangible in the form of 15 per cent reduction in scrap, and 40 per cent reduction in rework of hydraulic parts. In addition to these gains, the foreman of the machine shop stated that the clear designation on the drawing of the quality finish desired on specific surfaces saved much time formerly wasted in misapplication of effort. It had eliminated time-consuming arguments between shop and inspection, and the necessity for frequent contacts between engineering and the shop, particularly important in the case of outside production. Parts from the machine shop are of more uniform quality than before the adoption of the NASC designation of finish in microinches and the use of standard comparators to measure it. Leakage problems have almost disappeared.

No attempt is made to place a monetary value on such results. The economic gain to industry from a standard which provides a means for designating quantitatively and measuring qualitatively the surface finish is self-evident. Although the aircraft industry has adopted as its unit of measurement the "rms or root-mean-square" value of surface irregularities, the acceptance of this unit is by no means universal. There are five other proposed systems of measurement, each with strong proponents. The need is urgent for a meeting of minds and a redrafting in definite form, for national and international use, of the American Standard Association's (ASA) B46 standard on surface finish.

*Hose Clamps*. The importance of an intelligent approach in the choice of a standard to meet design requirements is well demonstrated in connection with drawing revisions changing hose-clamp usage on the Douglas C-54 airplane. Instead of using the more expensive and heavier AN-748 clamps for all purposes, their use was restricted to fuel, oil, coolant, and hydraulic lines, which constituted 15 per cent of the total of 1000 clamps employed, and at the suggestion of the standards engineers, another type was employed for all instrument, vacuum, deicer, air-vent and drain lines composing the remaining 85 per cent. This decision saved on each airplane some 50 lb weight and $42 or about $100,000 total not including an almost equal saving in installation time.

*Adjustable Hose Clamps*. A type of saving which standards engineers are constantly making is illustrated by the adoption of a type of hose clamp, with a wide range of adjustment. The wide variation in wall thickness of hose and the consequent production difficulty in selection of the proper size of clamp made this change important. Prior to converting to the new type, one North American Aircraft (NAAC) model required the stocking of 30 sizes which the new clamps cut to 7. The cost of inventory and stocking, handling, and selection of proper size was considerably reduced.

It is appropriate to remark that NAAC standards engineers, as a result of sponsoring the NASC project on hose clamps, were largely responsible for the development and introduction of the new clamp through assistance rendered the vendor in the form of engineering advice and testing over a long period. The same procedure is characteristic of the development of many valuable vendor products. It might also be pointed out that standardization results from wide acceptance and usage. Many parts used in large quantities on numerous models, even though not blessed by an AN, NASC, or other official standard designation are nonetheless true and valuable standards, having won their way by merit.

*Hose Lengths*. A final example, not of the spectacular type but rather one showing the slow, steady gains in industrial efficiency brought about by standardization, was suggested by NAAC also. This was a standardization of hose length for each inside diameter of hose. Before that action, the draftsman chose the length of hose for connections in $^1/_4$-in. increments according to his judgment, and the number of cut sizes carried in stock totaled about 55. Since standardization, this number has been reduced to about 13 with the familiar story of decreased purchasing, stocking, inventory, and handling costs.

Although only a few examples have been given of the almost countless number available, they have been chosen to demonstrate the various ways intelligent standardization brings about major improvements in product quality, lower product cost, and lower over-all manufacturing costs, not to forget overhead costs, reduced procurement time, and greater availability due to increased sources. These benefits are not intangible and not long-range; they are here and now; they do not stop but are permanent gains paying dividends month after month. In postwar industry it will be the individual company's money on fixed-price contracts which will be saved.

As this paper brings out later, the fields for the application of the standardizing principle are rapidly broadening—not narrowing. The highly trained design engineer is entering the picture to an increasing extent. While the need will remain for a specialized standards group in each company, there must be recognition of the necessity for some decentralizing of the standards function in engineering, for some participation by high-type design personnel.

The benefits from a standard are more than proportional to the quality and soundness of that standard. These in turn depend directly on the ability and experience of the men responsible for its formulation. We need a budget of engineering hours for standards work, reasonable in amount but honored, and not granted grudgingly. Most important of all, top engineering executives should make clear, down the line of organizational authority through the operating level that, when the need arises, a design engineer should be assigned to standards work as a part of his legitimate activity so that he is not made to feel that he is neglecting his job and his company's interests.

### THE PROCESS OF STANDARDIZATION

What is the nature of the standardizing process? The term, in the popular conception, is frequently a misnomer and the cause of a prejudice which hampers standards work. A brief analysis may be helpful in creating an understanding of standards. Co-operation is the basic element in standardization. Standards work involves the pooling of the widely varied knowledge and practical experience of able specialists. It serves to focus intensive thought on a particular problem and brings about a consideration of all its aspects. It is often a revelation to discover how great are the possible improvements that become evident under scrutiny in parts which may have been given broad but uncritical use for years. This process of creating a standard, the focusing of attention on a limited field, the clash of viewpoints, and the sincere group effort to secure the best result give to properly developed standards a quality that is seldom found in normal design. The process has a by-product of a value not often appreciated or even recognized. In a new or difficult field, 90 per cent of the effort may be expended before the actual work of drafting a standard begins. The discussions, however, crystallize thinking and assist in establishing basic principles on which sound design can proceed. Sometimes a year or more may pass before a concrete standard is evolved.

Standardization is one important answer to the increasing complexity and multiplicity of today's technical developments. Some aspects of these are so great as almost to overwhelm us, or at best to serve as a serious drag on our industrial efficiency, unless brought under control by organization and systemization of details. Designers dealing with new problems are not too keenly aware of the seriousness of the trail left behind them, which must be dealt with by manufacturing, stores, and maintenance.

The rapid tempo of recent times has made evident a trend worth noting because it is a partial answer at least to one of the chief barriers standardization has always faced, namely, the fear, as our English friend Mr. G. H. Nash phrases it, which many able designers have of standardization. This is a sort of claustrophobia, a feeling that once a standard has been set up it is a fixed dead thing. Any study of recent standardization indicates that the contrary is true; it is a progressive dynamic process. Yet the fact that a standard is a flexible and living creation and may be changed in a year to incorporate features making it a better standard does not affect its value as a standard, controlling for a period of time the design of a product as does a jig or fixture which is likewise subject to change.

### TREND TOWARD STANDARDIZING COMPLEX PARTS AND ASSEMBLIES

One of the broad trends in standardization work that has become increasingly evident within the last year or two is the enlargement of its scope. While much remains to be done in the matter of standardizing simple or "element" parts, the standardization of the more complex parts and assemblies opens another extremely important and relatively new field. Certain airplane components because of their nature have always been in effect standards, in that the same items are used on many types of airplanes. Such components are engines, propellers, wheels, tires, brakes, instruments, and many equipment items. Designers are accustomed to having these furnished and with few exceptions accommodate the airplane design to their dimensional and functional requirements. However, other parts through precedent have always been considered as under the airplane designer's control and are normally special for each airplane. They constitute a field somewhat jealously guarded by designers.

Owing to the aggressive action of the NASC electrical and hydraulic subcommittees, the lines have started to crumble in a number of places during the last year. It was found, in the case of circuit breakers, connector panels, relief valves, hand pumps, and 4-way selector valves, that technical requirements made it necessary to take co-operative action, through standardization, in order to secure proper function and quality. Naturally, a reduced cost followed the standardization. The point to be emphasized is that technical requirements compelled better design and better tooling than is generally possible in the case of a specific design for a given airplane.

With other parts or assemblies more intimately affecting the airplane, there is still the strong feeling that they must be tailored to the individual airplane, necessitating new design and new tooling in each instance. It is felt that this is a debatable assumption, that there are not a few instances where a really well-engineered design would be suitable for many airplanes. If a designer were given such a part as a standard he would make the necessary adjustments and compromises, which are inherent in the design process. The airplane would not suffer, while the part in question, as a result of the thought of many engineers during its standardization, should be lighter, superior functionally, and better from the production standpoint than with individual design. With larger requirements the tooling can be more extensive and the production cost less; sometimes only one half or one quarter. Thus is created another "building block." A large slice of design time can be devoted to improving the arrangement and basic structure of the airplane.

Such an extension of the standards field carries one important implication. Work of this type normally cannot be done effectively by our "standards" engineer, though his co-operation is quite essential; it is a task for our design engineers working co-operatively. Thus if we are to realize the further great gains possible by large production of many airplane components not now standard, a certain amount of time and effort must be allowed designers for standardization activities. Their active participation in such work would render it more realistic and of higher quality; it would also assist in breaking down present barriers to this fertile and profitable field.

### CO-OPERATIVE EFFORT ESSENTIAL TO DEVELOPMENT OF STANDARDS

One of the striking developments of the recent past has been the broadening application of the standardizing principle, some times without the conscious intent of standardization. This is natural when one realizes that standardization is fundamentally the organization of our thoughts, knowledge, and requirements on a given problem in an orderly logical manner and arriving at the best solution taking all pertinent factors into account. It has one important connotation, namely, that it is normally a co-operative act involving give and take between men with varying viewpoints.

*Conditions for Testing Airplane Equipment.* An example that is of current interest and of far-reaching importance is the work being done by a subcommittee of the West Coast Aircraft War Production Council (AWPC) under the chairmanship of Mr. Harold Adams of Douglas. This group, composed of leading technical specialists and designers from several companies, is preparing a specification setting forth limiting environmental conditions, such as extremes of temperature, pressure, humidity, vibration, and dirt, for which aircraft equipment shall be tested. Four supplementary specifications are being prepared to cover conditions peculiar to each of the following: Electrical, hydraulic, mechanical, and heat-exchanger equipment. In addition, specifications are being written describing general methods of test to determine the degree to which equipment meets the limiting conditions. A number of these specifications are now being circulated to airplane companies throughout the country, to equipment manufacturers, and to the Military Services for their comments. After completion of this work, the technical subcommittees of the Society of Automotive Engineers (SAE) will prepare, as required, detail specifications for the test of specific items of equipment.

That the results of this program, participated in by representatives of all interested parties, will have a marked influence on aircraft-equipment development appears clear. The problems of the vendor are simplified; he has to meet one set of conditions agreed on by industry, not as many sets as he has customers. A known measuring stick is set up permitting an engineering evaluation of his product. Uniform methods of test should allow acceptance of test results made in any reputable laboratory and should go far to eliminate the present costly duplication of testing. A definite incentive is given the capable vendor to improve the quality of his product.

*Spot-Welding Specification.* Another co-operative effort which promises to bear fruit has been the preparation of a new specification on spot-welding. Drawn up at the request of the West Coast Aircraft War Production Council (AWPC) by experienced engineers, members of the Western Aircraft Welding Committee, it was co-ordinated with and approved by all major aircraft companies in the country. It was then presented to the Working Committee of the Aeronautical Board (WCAB) as representing industry's views on a technically sound specification for insuring quality production with reasonable requirements for control and qualification testing. It is believed that a specification prepared in this manner represents a better engineering document than can be formulated by an individual organization or by the Government alone. The degree to which this industry proposal is incorporated in the present Army specification on spot-welding may well determine the extent to which industry will go in preparing in a similar manner sound specifications covering a number of our basic aircraft-manufacturing processes. Such co-operative standardization work offers possibilities for raising quality levels in production and reducing costs throughout the aircraft industry.

*Properties of Materials.* A final example of where the principle of standardization would perform a signal service lies in the field of materials. The subject is one of great interest to the author and was covered, as regards metals, in a recent article.[1] Great advances have been made during the war in the development of materials and their use, both from the design and fabricating standpoints. Conventional data and criteria concerning material properties have proved entirely inadequate and sometimes very misleading. For instance, it has become essential to know the mechanical properties of many metals both at and after being subjected to elevated temperatures; sometimes for functional design reasons, sometimes because of fabricating processes which may be facilitated by employing elevated temperatures. An outstanding unsatisfactory criterion is that for elongation based on a 2-in. gage length. Knowledge of this property may be of prime importance but the conventional information is often of little value.

It is proposed that a national agency first secure industry agreement on important criteria and methods of test to determine them. With these settled it becomes possible to obtain useful and accepted data through co-operative testing on the part of material vendors, users, and government agencies.

The next step is assembling in a carefully worked out standardized form all the data regarding each material, including not only technical data but procurement information on sources, standard and limiting sizes, and tolerances. As this is done for material after material, there will be built up over a period of a few years a single authoritative handbook which will contain in one place data, usually scattered through several sources, that can be referred to with confidence by the engineering, purchasing, inspection, and manufacturing departments of all companies and by government agencies.

In the coming years there will be few subjects of as vital importance to our industry as materials. By standardization of nomenclature, criteria, methods of test, and presentation of data, the aircraft industry can take a step of great importance in eliminating duplication of testing and discrepancies in design values often minor but nonetheless serious. The broader and more uniform dissemination of knowledge on materials will raise the quality of design and reduce general manufacturing costs.

### STANDARDIZATION PROGRESS IN AIRCRAFT INDUSTRY

The past year particularly has seen a significant trend in standardization work which has made new demands and placed new and different responsibilities on those directing and participating in standards activities. This is brought about by the fact that aviation has assumed its place among the major industries of this country. This reality has had its impact upon many other industries and their associated trade and professional organizations, with a consequent tremendous problem of co-ordination.

The requirements of the aircraft industry for new products, for precision manufacture, for small-size and lightweight products, reliable under extremes of environmental conditions, forced technical collaboration. The necessity for functional and dimensional interchangeability of similar parts and equipment compelled standardization. The challenge was accepted by the SAE and NASC standards bodies.

A critical situation arose. In their desire to do their utmost for the war effort, the industries, suddenly called upon to manufacture products for aircraft, activated their trade associations and the technical societies through which they had previously worked. We realized the need and value of this assistance but the necessity was equally obvious for channeling it through established agencies already handling aircraft standards work if confusion and delay were to be avoided. The solution was a series of interlocking subcommittees on which were men serving in a liaison capacity; the objective was an integration of complex activities in many diverse industries.

For example, in the electrical field, the chairman of the NASC Electrical Installation subcommittee was made a member of the SAE Subcommittee A-2 on aircraft electrical equipment on which were likewise representatives of the American Institute of Electrical Engineers (AIEE) and the National Electrical Manufacturers Association (NEMA). Similarly, the two latter organizations had the same representatives on the NASC subcommittee on which were also SAE representatives from subcommittees A-2, A-4, and A-8, the latter two having jurisdiction over instruments and radio. It was such a tie-up which made possible the great and rapid progress in the electrical field with no duplication of effort.

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[1] "Organizing Knowledge of Materials," by B. C. Boulton, *Product Engineering*, Feb., 1945, pp. 73–78.

These dealings with other long-established industries and organizations call for a considerable degree of both diplomacy and statesmanship. A nice judgment must be exercised at times when our views and practices conflict with those of the older organizations. Only in our own field can we expect directly to control our work and standards. In their fields the other industries must exercise such control even though we use the products. However, through foresight and a broad viewpoint we can exercise a marked influence and effective guidance with great benefit to the aircraft industry.

*Electrical Graphical Symbols.* One of the most interesting cases of such influence was in connection with the standardization of electrical graphical symbols. For many years the powerful electrical communication, radio, and power industries had developed their own symbols, many peculiar to the single field, and had not been able to agree to a standard. Aircraft engineers had to interpret drawings from all three groups and in addition had their own symbols. A subcommittee of the American Standards Association (ASA), charged with the task of standardizing these symbols, finally invited two representatives of the aircraft industry, including Mr. Warren Boughton, chairman of the NASC electrical subcommittee, to participate in the job. Their advent greatly expedited the work. It proved possible to secure agreement on and to issue a war emergency standard covering all fundamental symbols for the entire electrical industry of this country. So was established a common engineering language, and wiring diagrams could be intelligible to all. In this instance, as in the case of surface-finish standards, the American Standards Association acted as a co-ordinating body.

*Cylindrical Fits.* A further important example of the value of the ASA in performing this function is the War Emergency Standard on cylindrical fits which was also co-ordinated with the British Standards Institution and in large part accepted. It is strongly recommended that further recognition be given to the ASA as a national co-ordinating body on standards affecting several industries.

### REQUIREMENTS FOR SUCCESSFUL STANDARDIZATION EFFORT

In all this work co-operation is the keynote. Each group must recognize the real interests of the other groups and direct its efforts so that these basic interests are promoted and not injured. Throughout the give and take involved, clear thinking and firmness are required so that the requirements of technical quality necessary for aircraft are obtained.

If a true picture has been presented it should be clearly evident that the aircraft industry must be represented by broad-gage technically qualified men. They must be big enough to submerge petty professional jealousies, to see that full credit, or even more, for accomplishments goes to the other fellow. It is just as evident that between the standard bodies representing the aircraft industry there must be harmony. Care must be exercised by each to avoid encroaching on the other's bailiwick and each must be quick to support the other.

In a recent article, Mr. Charles E. Wilson, president of General Electric and past vice-chairman of the War Production Board said, "One of the really priceless dividends we derive from the last few years is a demonstration of the fact that industry can co-operate intelligently with Government. Let us extend that co-operation indefinitely—."

Ranking high in importance to the war effort has been the standardization work of the SAE and NASC organizations. Their efforts have provided many a specification for urgently needed new materials where no recognized specification previously existed. Standardization of aluminum-alloy and steel tubing sizes, of extrusions, of new rolled shapes prevented shortages so critical that they threatened disruption of airplane production lines. Elimination of hundreds of special requirements not only largely stepped up mill production but resulted in substantial decreases in production costs. Scores of standard parts have been developed and improvements worked out on existing AN standards. In addition to this work on materials and parts our industry has devoted long, patient, and co-ordinated effort to the development of specifications controlling the preparation of drawings, technical data furnished the Government, and to a standard airplane procurement specification. In the greak bulk of all this work co-ordination has been through the Working Committee of the Aeronautical Board (WCAB).

### THE WORKING COMMITTEE OF THE AERONAUTICAL BOARD

The over-all effort has been great, corresponding to the stakes, and reflects high credit on engineers throughout the aircraft industry who accomplished it, and on engineering management which authorized it. Nor has it been any sinecure for either the Working Committee of the Aeronautical Board or industry due in large part to initial differences in approach to problems. There have been discouraging moments when it seemed as if some of these endeavors were in vain. Patience and understanding were present on both sides in these mutual efforts on the part of industry and the WCAB. The former came to appreciate better the problems of co-ordination between the Services and other Government agencies, and of huge procurement which faced the WCAB which had to be resolved. On the other hand, it is believed that the latter came to appreciate the sincerity and technical competence of industry's work and its value to them and acquired an understanding of industry's problems and viewpoint. Between the two groups has grown up a mutual liking and respect and a realization of the need one has for the other.

Following Mr. Wilson's thought, many of us would like to see this hard-won relationship develop into a genuine partnership between the WCAB and the aircraft industry on standardization matters. We would like to see a further strengthening of the authority and technical responsibility of the WCAB in handling standards work for both military services. When one Service only is interested in the development of a new standard, if it could be discussed within the Board by the representatives of the Service concerned, it is believed that the difficulties sometimes encountered in obtaining agreement on a common standard, should the other Service later wish to adopt it, would be much reduced. The day may come, and before too long, when industry is invited to have representatives on the WCAB and we may have ANI-Army, Navy, Industry standards.

The practical success of such a proposal requires maintenance of mutual confidence, of continued technical competence and a broad viewpoint on the part of industry, and of an understanding appreciation of and consideration for industry's interests and problems on the part of the WCAB. It is difficult to appraise the potentialities in such a broad development for improving the technical quality of both military and commercial aircraft, for reducing their cost, and for simplifying stocking and maintenance work in the far-flung airports of the world where our future commercial and military airplanes will be serviced.

### ACKNOWLEDGMENTS

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# *An* AMERICAN SOCIETY *of* ENGINEERS

## By VIRGIL M. FAIRES

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SINCE it is becoming more apparent day by day that all engineers should be members of some single organization in order to realize the advantages of a consolidated profession, I am proposing a form of organization, which, in its general outlines, seems possible of fulfillment.

This proposal for an association of engineering societies would allow present societies to continue operation almost without change from their established procedures. The only change proposed is that present societies give up certain functions which affect all branches of engineering, but which would not reduce the service to their membership. In fact, over a period of years, certain economies could be effected which would result in increased service to the membership of each.

Evidently, engineers cannot obtain all the benefits of solidarity without giving something for them in return. The various societies would be required to compromise their interests to some extent. The necessity is for something more basic than an informal co-operation between societies. The ultimate goal should be an organization so strongly representative of the interests of the engineering profession that all engineers would virtually be obligated to membership. An outline of this suggested organization follows:

### PROPOSED AMERICAN SOCIETY OF ENGINEERS

1 In order to identify the top organization, I shall call it the American Society of Engineers (A.S.E.).

2 Existing societies would be referred to as functional societies, inasmuch as they are designed to serve a particular group of engineers.

3 Functional societies which joined the A.S.E. would be designated as associated societies.

4 The associated societies would pay into the A.S.E. a certain fee for each of their members. Thus, a member of an associated society would be automatically a member of the A.S.E.

5 Associated societies, in general, would continue to charge the same membership fees as at present, and maintain the same classes of membership.

6 If an existing society, which qualified as an associated society, charges a low membership fee (as the $5 of the Society for the Promotion of Engineering Education), it would no doubt be necessary for such a society to add all or nearly all of the membership fee for the A.S.E. to its regular dues for those members who were not already members of the A.S.E. Members of such societies who did not qualify as engineers would not be eligible for membership in the A.S.E.

7 If an engineer were a member of two or more associated societies, he would be charged only once for the fee which was subscribed to the A.S.E.

8 Engineers could join the A.S.E. without being members of an associated society. This plan would care for engineers who have interests which are not provided for by existing societies. The fee for membership in the A.S.E. should be the same, or nearly the same, as the fee paid to the A.S.E. per member by the associated societies.

In further explanation of eligibility to membership, one of the primary objectives of forming this association should be to make it so strong that a practicing engineer would feel that he must be a member. Therefore, this feature is a most significant one. It would be the means of getting practically all engineers into a single association. If it were properly promoted, all new engineering graduates who were not yet sure of the nature of their future professional activity would join the A.S.E. In fact, it might not be amiss to make a recognized engineering degree the qualifications for membership in the A.S.E. alone. Those who were members of the A.S.E. alone would constitute a prime mailing list for the associated societies, so that in the long run, this feature would serve to increase the membership in the associated societies.

The final form of over-all engineering organization should be such that it not only included those who were already members of major engineering societies, but also provided an almost irresistible inducement for all engineers to join. Only when all engineers, or nearly all, are members of a single professional society will engineers develop the group consciousness and integration that go with professional recognition and professional pride. If it seems best, direct membership in the A.S.E. alone might be limited to a period of years, after which transfer of membership to an associated society would be required.

9 The organization would be initiated by a committee whose members represented as many as possible of the foremost engineering societies. This committee would be required to draw up by-laws and a constitution, which included means of electing officers of the A.S.E. and of amending the by-laws and constitution.

10 The A.S.E. would create a committee to draw up a statement of policies to guide its actions, and these policies would require approval by associated societies representing a majority of the membership of all associated societies.

11 If future developments in engineering warrant, new functional societies could be formed and admitted to the American Society of Engineers in accordance with regulations to be established. The A.S.E. could offer considerable assistance in organizing a new functional society.

12 Each of our present societies would retain its autonomy, except for certain functions which could best be administered for all societies (accompanying organization chart).

13 The A.S.E. would work for consistency in the rules and regulations of the various functional societies, but would have no authority to force a change. However, changes in rules and regulations of the associated societies would require approval by the A.S.E., which would be guided by general policies as approved by associated societies.

14 Qualifications for membership in the A.S.E. should not be lower than qualifications required by associated societies.

15 The union would have to be irrevocable. There would be no strength where units might secede when events were not to their liking.

### COMMENTS ON ORGANIZATION CHART

1 The A.S.E. would logically perform the functions of the E.C.P.D., which would desirably be included in the top society intact as it is now constituted.

2 The A.S.E. should perform the necessary duties concerning the problems of licensing engineers.

3 Participation of the A.S.E. in the co-ordination of meetings would be advisory. Arrangements could be made for a short meeting, say, of one day's duration, of all engineers, which meeting might come between meetings of various associated societies so as to be most convenient to those attending national meetings.

4 The work of standardization could profitably be centralized.

5 The A.S.E. would have its own publications, but this division should be able to find ways and means to effect savings in the publications of the associated societies.

### ADVANTAGES CITED FOR PROPOSED SOCIETY

Some of the potential advantages accruing from the functioning of such a society as the proposed A.S.E. are as follows:

1 With practically all engineers included in its membership, the A.S.E. would constitute an influential and powerful force for promoting the welfare of the engineering profession in all its branches.

2 The income available to an over-all engineering society of this character would make possible the promotion of a wide range of activities for the benefit of the engineering profession in general and greater service to the individual members.

3 There would be a growth of professional consciousness and pride.

4 A young engineer who joined the A.S.E. would maintain contact with his profession and would soon join that associated society which most nearly fulfilled his needs, as these needs became evident.

5 This plan provides means of evolution to meet the changing needs of the profession.

6 The organization and operation of existing societies would be affected to a minimum degree. These societies would achieve solidarity at a relatively small cost.

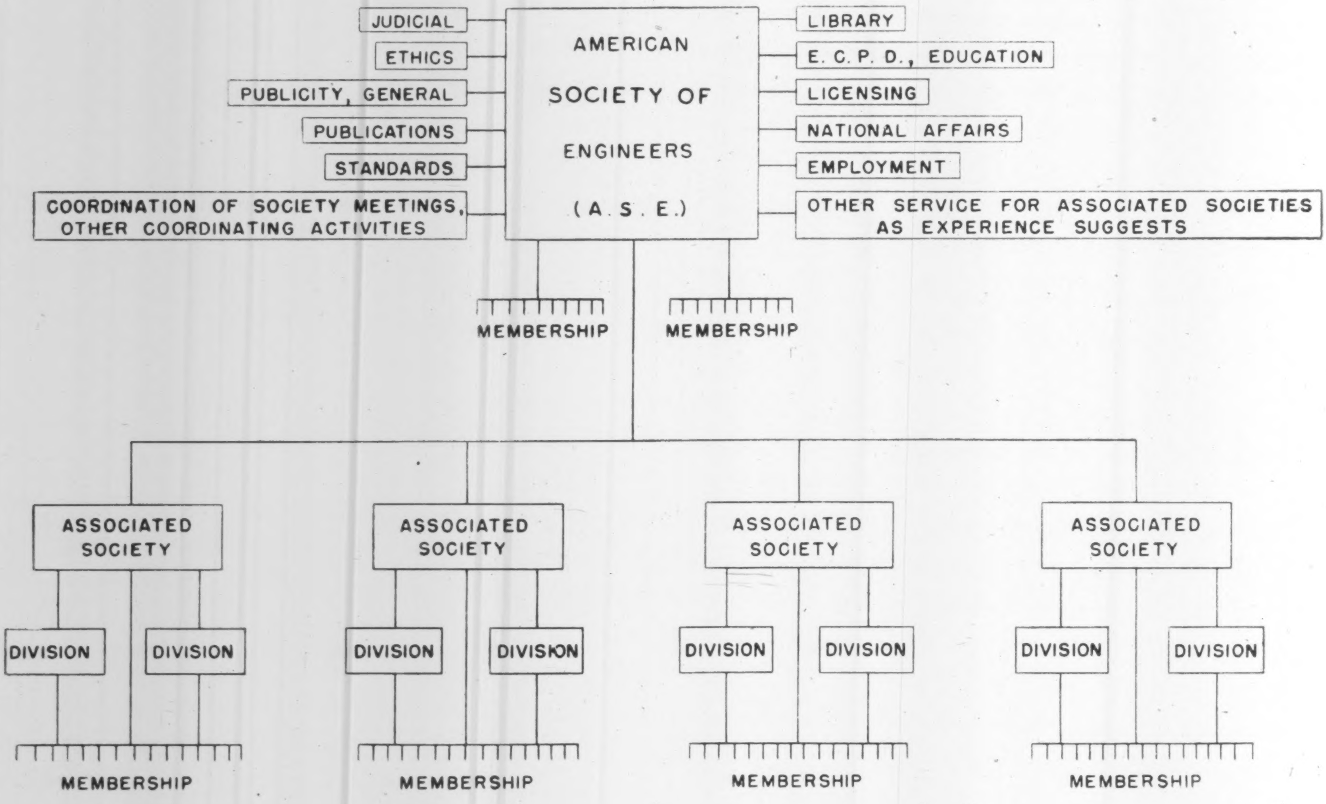
7 The A.S.E. would undertake certain public-relations functions (such as collective-bargaining arguments, union proposals, relations with W.L.B., etc.) so that the associated societies could devote their entire efforts to the exchange of professional engineering ideas and to the advancement of engineering knowledge. With nearly all engineers members of the A.S.E., the best talent for public relations could be employed.

8 The A.S.E. could afford to provide the finest engineering talent to address its local meetings throughout the country.

### STRENGTH MUST COME FROM WITHIN THE PROFESSION NOT FROM UNIONIZATION

I personally feel that a strong professional engineering society will be the only means to combat successfully the unionization of engineers. As long as truck drivers and welders trained in three weeks' time can make more money than graduate engineers, the labor unions will have an appeal to a large section of our profession. It may already be too late to avoid unionization, an abhorrent thing for any true member of the engineering profession.

Organization Chart for an American Society of Engineers


JUDICIAL
ETHICS
PUBLICITY, GENERAL
PUBLICATIONS
STANDARDS
COORDINATION OF SOCIETY MEETINGS, OTHER COORDINATING ACTIVITIES
AMERICAN SOCIETY OF ENGINEERS (A. S. E.)
LIBRARY
E. C. P. D., EDUCATION
LICENSING
NATIONAL AFFAIRS
EMPLOYMENT
OTHER SERVICE FOR ASSOCIATED SOCIETIES AS EXPERIENCE SUGGESTS
MEMBERSHIP
MEMBERSHIP
ASSOCIATED SOCIETY
ASSOCIATED SOCIETY
ASSOCIATED SOCIETY
ASSOCIATED SOCIETY
DIVISION
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MEMBERSHIP
MEMBERSHIP
MEMBERSHIP

# NOMOGRAPHS *for Analysis of* METAL-CUTTING PROCESSES

By M. EUGENE MERCHANT and NORMAN ZLATIN

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In previous publications[1,2] a method has been developed and described for analyzing certain classes of metal-cutting processes in terms of variables commonly employed in the analysis of other mechanical systems; variables such as shearing strain, friction coefficient, shear strength of the metal, etc. This method of analysis is useful both in testing and research and is intended to supplement standard methods of machinability testing. In this paper, nomographs are presented, based on the previously derived equations, for convenient use in analyzing all *orthogonal* cutting processes wherein a *continuous* chip is produced (as distinguished from a segmental-type chip, such as occurs when machining cast iron).

Strictly speaking, an orthogonal cutting process is one wherein the tool has a single straight cutting edge which lies perpendicular to the direction of motion of the tool relative to the work. However, many common types of machining operations are good approximations to this condition as discussed in the previous publications. On the other hand, if this method of analysis is to be applied to laboratory testing or research, then a true orthogonal cutting arrangement is actually the simplest and most convenient type of setup for this purpose, as will be discussed later.

### WIDE APPLICATION OF NOMOGRAPHS

Among the uses of the method of analysis and testing which is facilitated by the nomographs presented herein may be mentioned the following:

1 The testing of steels and other machinable materials under chosen cutting conditions to determine such data as the shear strength exhibited by the metal in the cutting process, the ratio of the amount of work going into shearing the metal to the amount dissipated by friction between chip and tool, the coefficient of friction between chip and tool, the shearing strain undergone by the metal during its removal, the rate of shear of the metal, and the actual amount of work dissipated in shear, in friction, and over-all, per unit volume of metal removed.

2 The testing of various types or compositions of tool materials under chosen cutting conditions, where such data as coefficient of friction between chip and tool, friction force between chip and tool, and the ratio of the work dissipated in friction to that dissipated in shear may be of particular interest.

3 The testing of cutting fluids, where data on the variation of some of the foregoing quantities with variations in cutting speed, feed rate, rake angle, work material, tool material, etc., may be of considerable value.

4 Fundamental investigations into the mechanics of the cutting process, to study such phenomena as plasticity conditions,[3] temperature distribution, etc., in relation to such practical quantities as power consumption and cutting-tool life.

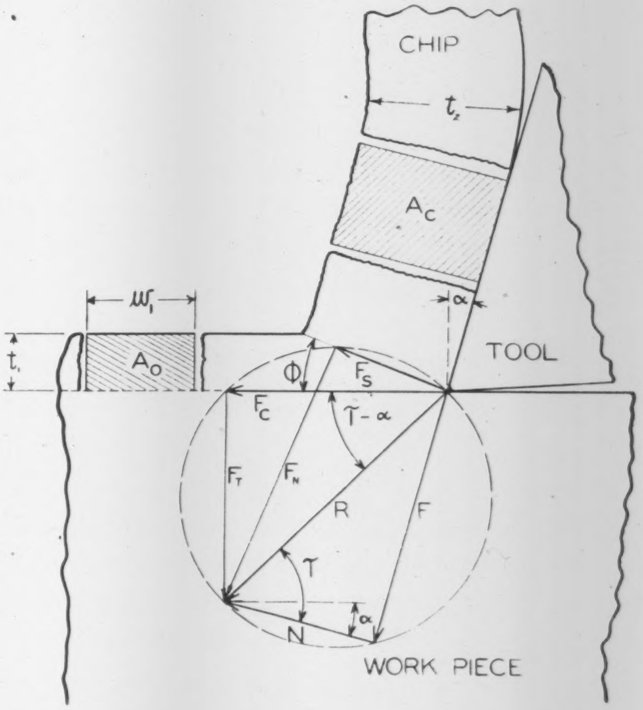

FIG. 1 GEOMETRY OF CHIP FORMATION AND FORCE SYSTEM IN ORTHOGONAL CUTTING FOR A CONTINUOUS CHIP

### CHIP FORMATION AND FORCE SYSTEM IN ORTHOGONAL CUTTING

The geometry of chip formation, and the force system present in orthogonal cutting, discussed in detail in the earlier publications, are illustrated schematically in Fig. 1. The essential feature of the geometry of chip formation is that the chip is produced from the workpiece by a process of internal shear or plastic flow in a narrow region which may be quite accurately represented by a single plane. This plane is shown making an angle $\phi$ with the surface being generated, in Fig. 1, and is known as the "shear plane." Angle $\phi$ is known as the "shear angle." The nature of the force system, shown in Fig. 1, is self-explanatory. Its derivation has been discussed in the earlier publications. From the geometry illustrated, the following relationships, used to carry out this method of analysis, have been derived[1,2]

$$r_c = \frac{16.4\, t_1 w_1 \rho}{m} = 16.4\, \frac{A_o \rho}{m} \qquad [1]$$

$$\tan\phi = \frac{r_c \cos\alpha}{1 - r_c \sin\alpha} \qquad [2]$$

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[1] "Basic Mechanics of the Metal-Cutting Process," by M. E. Merchant, *Journal of Applied Mechanics*, Trans. A.S.M.E., vol. 66, 1944, p. A-168.

[2] "Mechanics of the Metal-Cutting Process I. Orthogonal Cutting and a Type 2 Chip," by M. E. Merchant, *Journal of Applied Physics*, vol. 16, 1945, pp. 267–275.

Contributed by the Research Committee on Metal-Cutting Data and Bibliography, and on Cutting Fluids, and the Production Engineering Division and presented at a meeting of the Cincinnati Section, Cincinnati, Ohio, October 2–3, 1945, of The American Society of Mechanical Engineers.

[3] "Mechanics of the Metal-Cutting Process II. Plasticity Conditions in Orthogonal Cutting," by M. E. Merchant, *Journal of Applied Physics*, vol. 16, 1945, pp. 318–324.

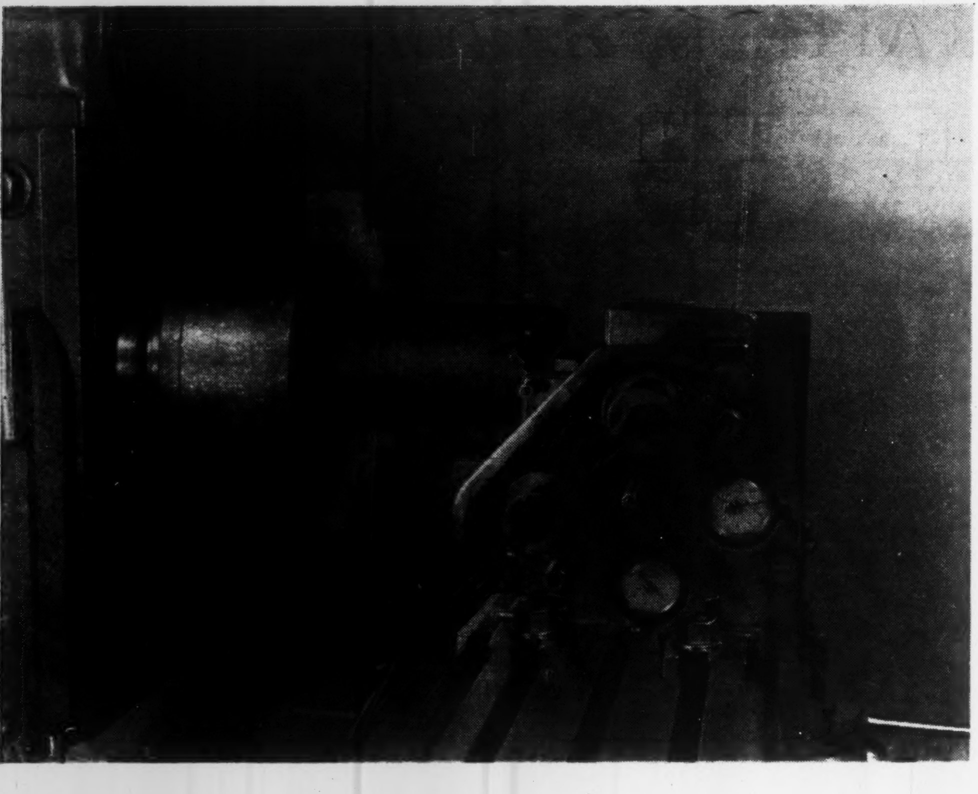

FIG. 2 SETUP AND TOOL DYNAMOMETER SUITABLE FOR OBTAINING DATA REQUIRED FOR ANALYZING METAL-CUTTING PROCESSES

$$\epsilon = \cot\phi + \tan(\phi - \alpha) \quad \text{[3]}$$

$$V_s = V_c \frac{\cos\alpha}{\cos(\phi - \alpha)} \quad \text{[4]}$$

$$V_f = V_c r_c \quad \text{[5]}$$

$$\mu (= \tan\tau) = \frac{F_t + F_c \tan\alpha}{F_c - F_t \tan\alpha} \quad \text{[6]}$$

$$F = F_t \cos\alpha + F_c \sin\alpha \quad \text{[7]}$$

$$S_s = \frac{F_c \sin\phi \cos\phi - F_t \sin^2\phi}{A_o} \quad \text{[8]}$$

$$S_n = S_s \tan(\phi + \tau - \alpha) \quad \text{[9]}$$

$$W_f = \frac{F\, r_c}{A_o} \quad \text{[10]}$$

$$W_s = S_s\, \epsilon \quad \text{[11]}$$

$$W_c = \frac{F_c}{A_o} \quad \text{[12]}$$

From Equation [12] it is evident that the cubic inches of metal removed per horsepower-minute is given by

$$E = \frac{396{,}000\, t_1 w_1}{F_c} \quad \text{[13]}$$

In the foregoing equations

$r_c$ = cutting ratio = $t_1/t_2$ (see Fig. 1)
$t_1$ = thickness of chip before removal
$w_1$ = width of chip
$\epsilon$ = shearing strain undergone by metal in chip during process of its removal
$V_s$ = velocity at which metal is sheared in plane of shear
$V_f$ = velocity of chip flow; velocity of chip relative to tool
$V_c$ = cutting velocity; velocity of tool relative to workpiece
$\mu$ = coefficient of friction acting between sliding chip and tool face
$S_s$ = mean shear stress on shear plane; mean shear strength of metal being cut
$S_n$ = mean normal or compressive stress on shear plane
$W_f$ = work done in overcoming friction between chip and tool, per unit volume of metal removed
$W_s$ = work done in shearing of metal, per unit volume of metal removed

The meanings of the remaining symbols employed are given with sufficient detail on the alignment charts which follow, or, in some cases, may be evident from Fig. 1.

### APPLYING ANALYSIS TO LABORATORY TESTING

The foregoing equations are the mathematical tools employed in analyzing an orthogonal cutting process wherein a continuous chip is being generated. The quantities $t_1$, $w_1$, $\rho$, $V_c$, and $\alpha$ should be known from the conditions of the cutting operation being studied. The quantities $m$, $F_c$, and $F_t$ must then be measured by use of suitable apparatus. If the analysis is being applied to laboratory testing or research, which is probably its major field of usefulness, then a very simple type of cutting operation can be used which considerably facilitates the determination of the previously enumerated variables and at the same time insures a strictly orthogonal cutting process. This consists of employing a tubular workpiece, rotated about its axis by suitable means, and a cutting tool having a straight cutting edge and so set that this edge is parallel to a diameter of the tube. The cutting tool is then fed in a direction parallel to the axis of the tube, removing a chip from the end surface and continually shortening the tube. The dimension $t_1$ becomes the feed of the tool per revolution of the workpiece, while $w_1$ is the wall thickness of the tube. Such an arrangement is shown in operation in Fig. 2. The quantities $F_c$ and $F_t$ can then be determined by use of a suitable tool dynamometer capable of measuring two components, such as the one illustrated in Fig. 2. Chips from the operation are collected and the quantity $m$ can then be determined by weighing known lengths of these chips on a balance having suitable sensitivity.

Having obtained these data, the values of the dependent

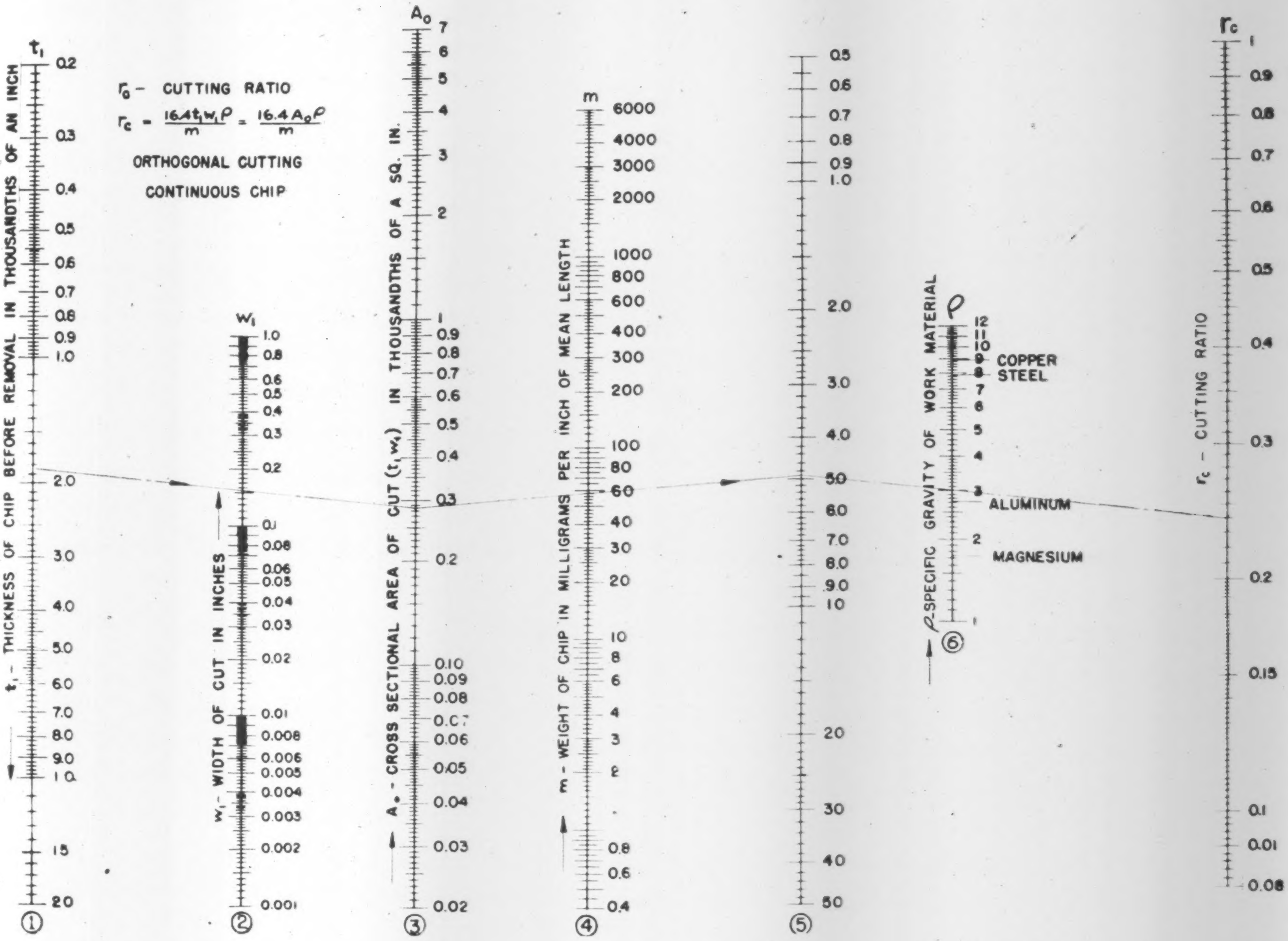

FIG. 3 CUTTING-RATIO CHART

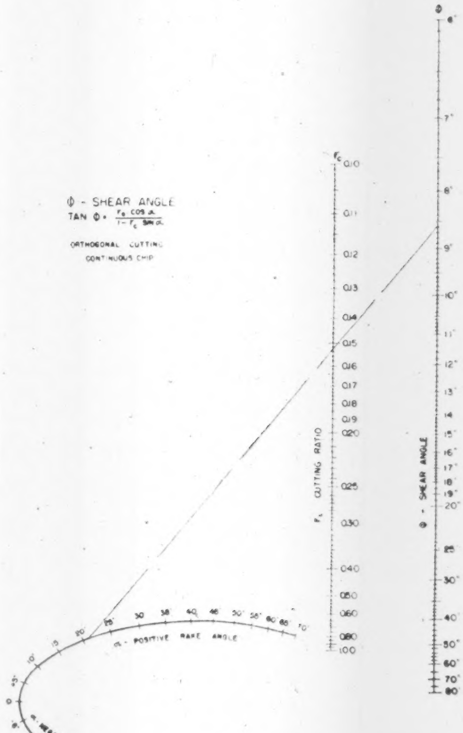

FIG. 4 SHEAR-ANGLE CHART

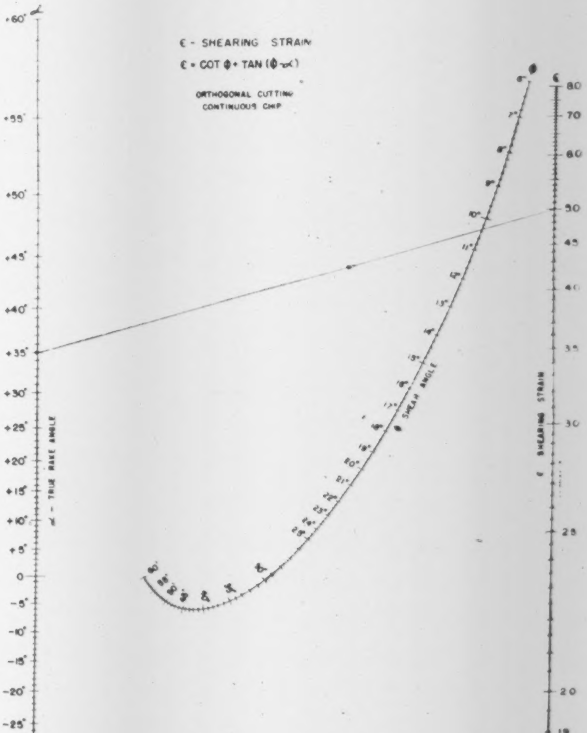

FIG. 5 SHEARING-STRAIN CHART

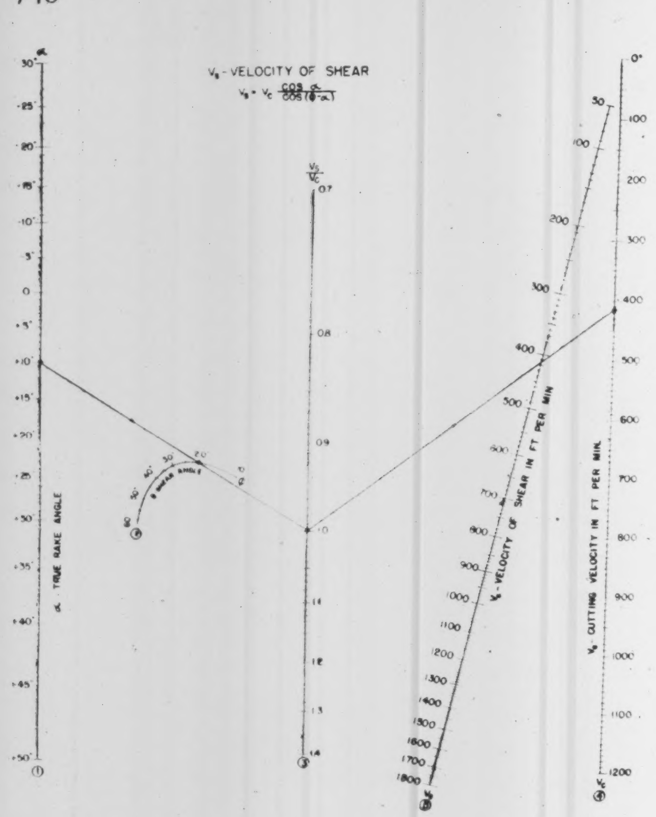
V_s - VELOCITY OF SHEAR
V_s = V_c cos α / cos(φ-α)
α - TRUE RAKE ANGLE
V_s/V_c
φ SHEAR ANGLE
V_s - VELOCITY OF SHEAR IN FT PER MIN
V_c CUTTING VELOCITY IN FT PER MIN

FIG. 6 VELOCITY-OF-SHEAR CHART

variables in the preceding equations can then be calculated, yielding the desired useful information.

### FUNCTIONS OF ALIGNMENT CHARTS OR NOMOGRAPHS

However, many of these equations involve lengthy multiplications, sums and differences, and trigonometric functions. Therefore, to facilitate the calculations, alignment charts or nomographs have been constructed for use in solving all but the simpler of these thirteen equations. In addition to serving this purpose, the charts in many instances present a visual picture of the relationships between the variables in the equations.

The graphical solution of Equation [1] requires the use of a logarithmic alignment chart involving 5 variables, as shown in Fig. 3. This type of nomograph is the simplest standard form and therefore requires no explanation of its method of use.

However, it should be pointed out that in applying this chart to various types of machining operations, the quantities $t_1$ and $w_1$ may have various interpretations. For instance, in turning or boring $t_1$ may be taken as the feed per revolution, while in milling the feed per tooth may be used. Then the quantity $w_1$ becomes the depth of cut in each case. It is only necessary that the user select such values for $t_1$ and $w_1$ that their product truly represents the cross-sectional area of the cut being taken.

The alignment chart for Equation [2] is of the recurrent variable type, as shown in Fig. 4. This chart brings out the interesting fact that two values of $\alpha$ usually exist for a given value of $r_c$ and $\phi$. Its method of use is evident.

The chart, Fig. 5, representing Equation [3] is similar to the one just described in that there are two functions of the same

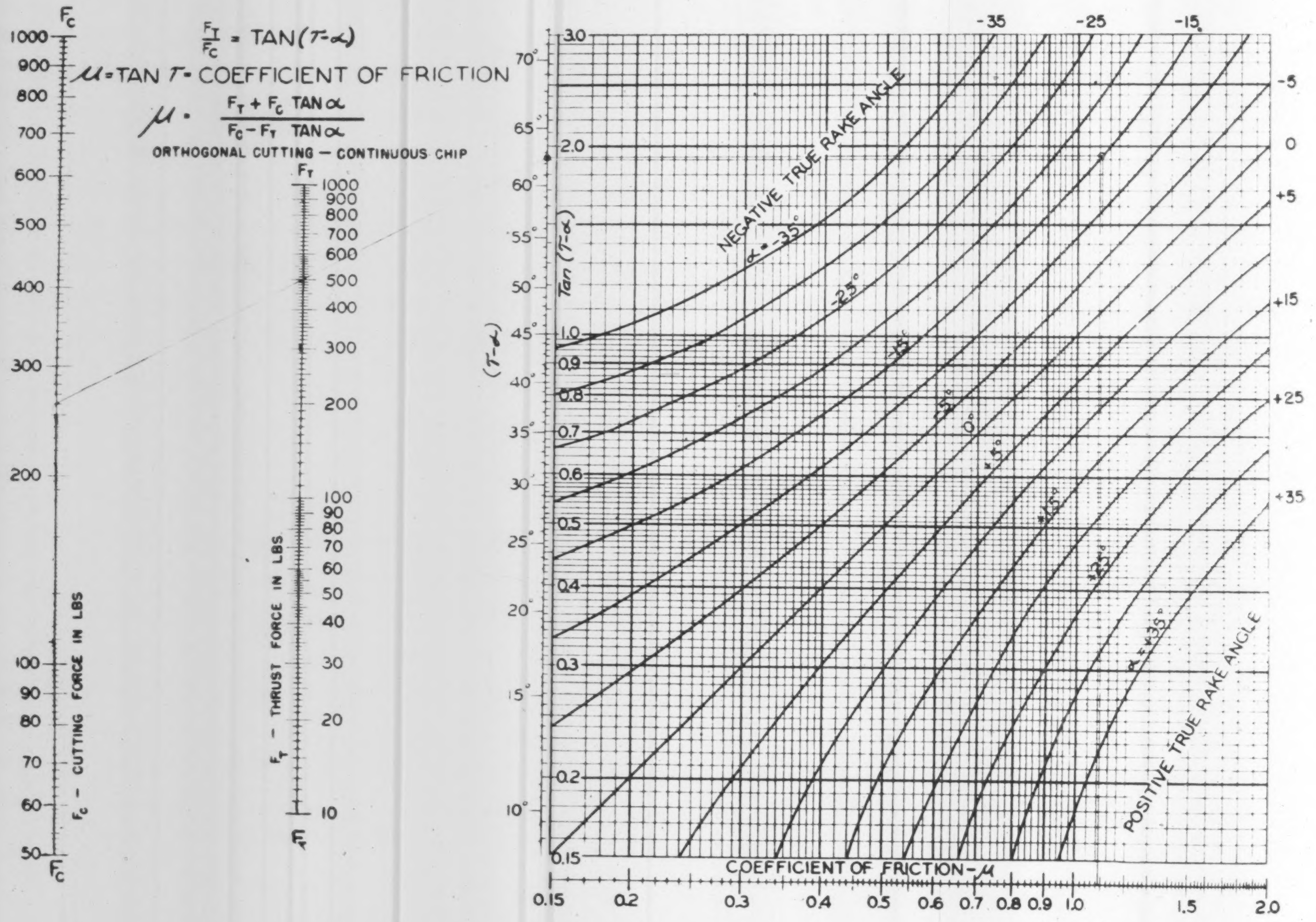

FIG. 7 COEFFICIENT-OF-FRICTION CHART

variable in the equation. Nevertheless, as in the previous chart, only a single straight line is required in solving the equation.

The combination of the recurring variable and the complexity of the equation make it necessary to solve Equation [4] by combining two different charts as shown in Fig. 6. The ratio $V_s/V_c$ is first found by use of the recurrent variable type of chart. Then by employing the Z type of chart, the equation is finally solved. From the chart the limitations of the equation are quite evident.

The solutions of Equation [6] are conveniently represented by a combination of an alignment and a network chart, as shown in Fig. 7. By this method Equation [6] is solved indirectly, i.e., first tan $(\tau - \alpha)$ is found and then $\mu$ or tan $\tau$ is determined. The equation is solved as follows: (1) Obtain the magnitude of $(\tau - \alpha)$ from the known values of $F_t$ and $F_c$; (2) move horizontally over from this value of $(\tau - \alpha)$ to the curve for the proper value of true rake angle $\alpha$ and then travel vertically down to the scale representing the values of the coefficient of friction $\mu$.

Equation [7] is solved by use of a network graph superimposed on an alignment chart, as shown in Fig. 8. The value of $F$ is found at the location of the intersection of a vertical line running up from the rake-angle scale and a straight line which passes through the two points representing the values of $F_t$ and $F_c$.

Equation [8] is solved by use of the unique nomograph shown in Fig. 9. The solution is obtained in two steps. A line is drawn through the value of $F_t$ and the termination of a vertical line traveling from the shear-angle scale to the point representing the value of $F_c$, thus locating a point on the transfer axis. This point is then connected with the proper value of $A_o$ to find the required value of $S_s$ on the diagonal scale.

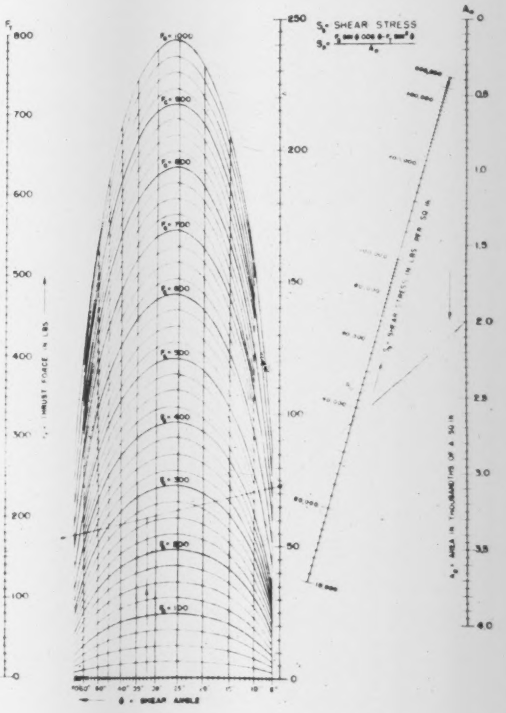

FIG. 9 SHEAR-STRESS CHART

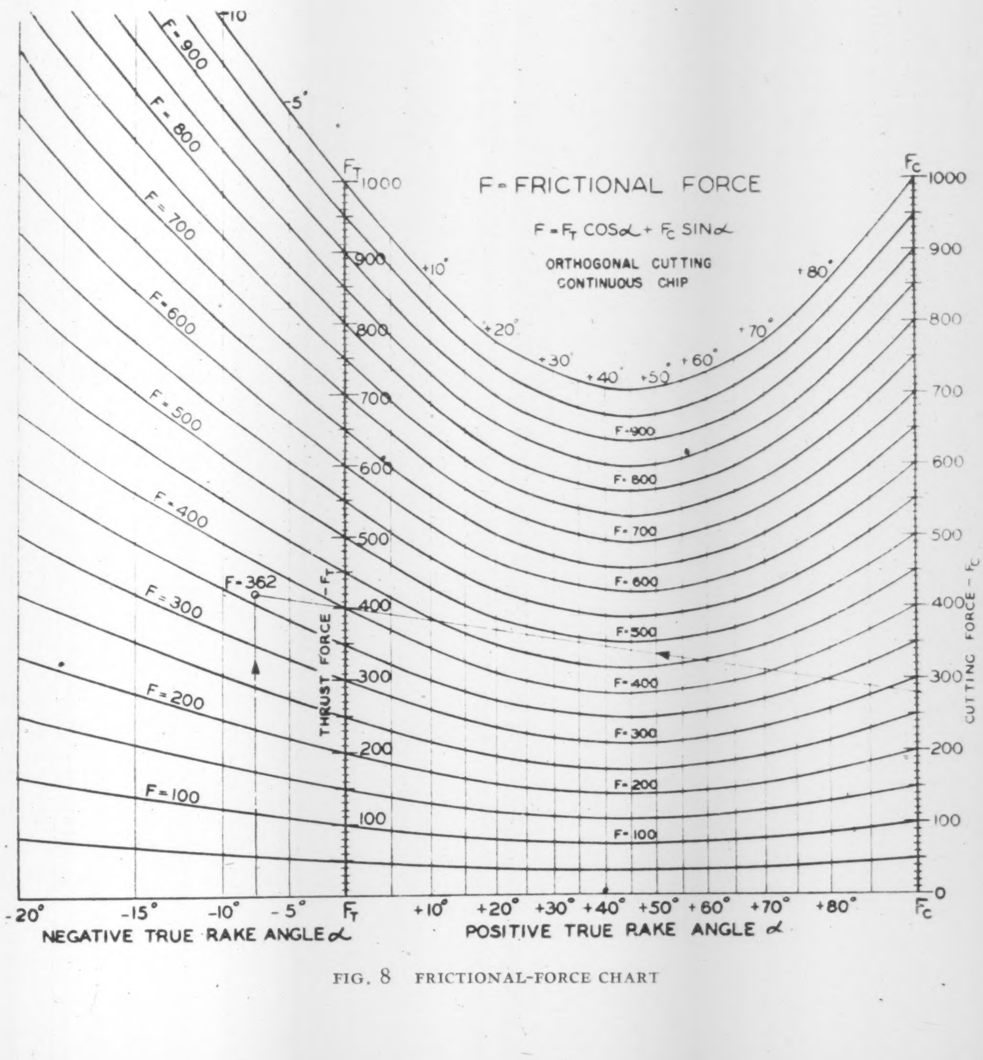

FIG. 8 FRICTIONAL-FORCE CHART

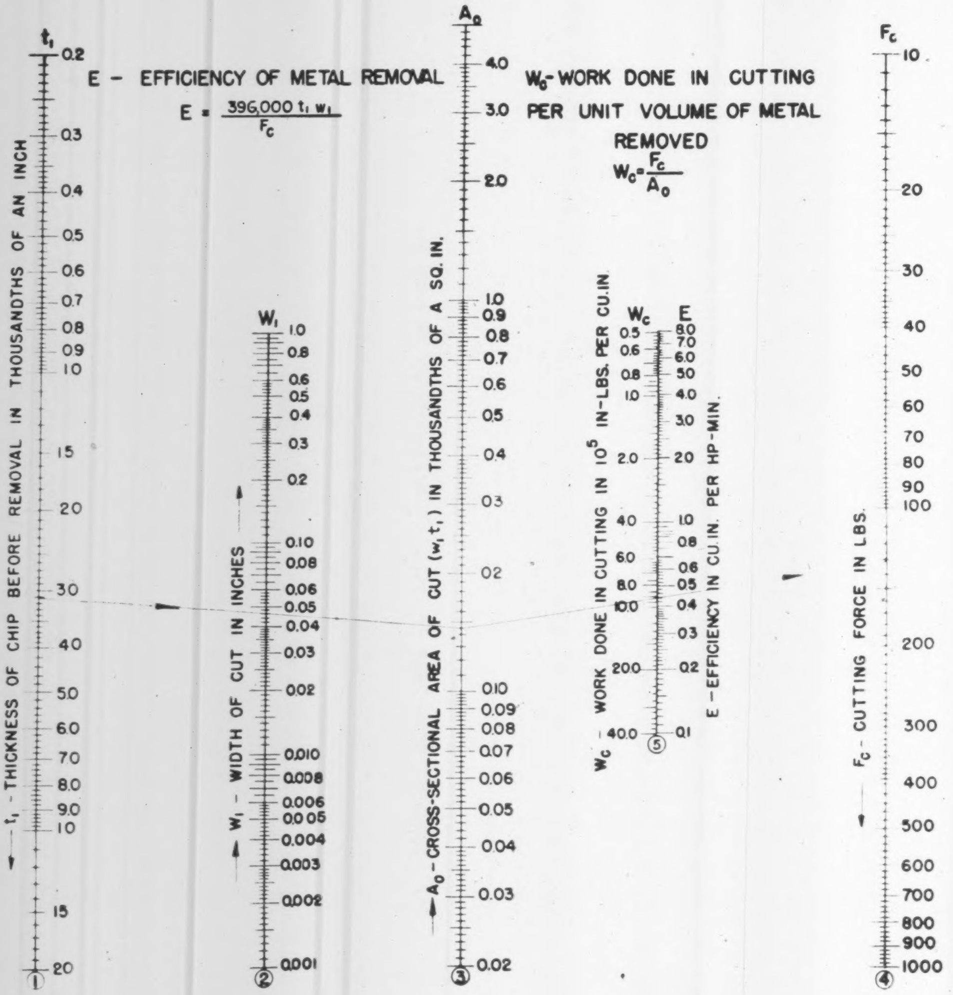
E - EFFICIENCY OF METAL REMOVAL
$E = \frac{396{,}000\, t_1 w_1}{F_c}$
$W_c$ - WORK DONE IN CUTTING PER UNIT VOLUME OF METAL REMOVED
$W_c = \frac{F_c}{A_0}$
$t_1$
$t_1$ - THICKNESS OF CHIP BEFORE REMOVAL IN THOUSANDTHS OF AN INCH
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.5 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10 15 20
①
$W_1$
$W_1$ - WIDTH OF CUT IN INCHES
1.0 0.8 0.6 0.5 0.4 0.3 0.2 0.10 0.08 0.06 0.05 0.04 0.03 0.02 0.010 0.008 0.006 0.005 0.004 0.003 0.002 0.001
②
$A_0$
$A_0$ - CROSS-SECTIONAL AREA OF CUT ($w_1 t_1$) IN THOUSANDTHS OF A SQ. IN.
4.0 3.0 2.0 1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.10 0.09 0.08 0.07 0.06 0.05 0.04 0.03 0.02
③
$W_c$ E
$W_c$ - WORK DONE IN CUTTING IN $10^5$ IN-LBS. PER CU.IN.
0.5 0.6 0.8 1.0 2.0 4.0 6.0 8.0 10.0 20.0 40.0
E - EFFICIENCY IN CU.IN. PER HP-MIN.
8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.8 0.6 0.5 0.4 0.3 0.2 0.1
⑤
$F_c$
$F_c$ - CUTTING FORCE IN LBS.
10 20 30 40 50 60 70 80 90 100 200 300 400 500 600 700 800 900 1000
④

FIG. 10 CHART FOR EFFICIENCY OF METAL REMOVAL AND WORK DONE IN CUTTING

The factors involved in Equations [12] and [13] can be combined in such a way as to use one chart to get the solutions of both equations simultaneously. This is done in Fig. 10. Its use is self-evident since it is one of the standard forms. However, again, as in the chart, Fig. 3, the proper interpretation of the quantities $t_1$ and $w_1$ must be made in terms of the particular machining operation being analyzed.

It has been found that by the use of the method of analysis outlined here, employing the foregoing charts, results can be obtained which are of real value in interpreting the behavior of machining operations. It is to be hoped that the publication of these charts will aid in making the use of such analyses of machining operations more widespread and of greater service.

## ACKNOWLEDGMENT

The authors wish to acknowledge the helpful advice of Dr. Max Kronenberg, member of the research staff, in connection with the preparation of the nomographs, and the able assistance of Miss Ellen Jane Tuxworth and Miss Jane Alexander, both of this department, in drawing up the charts.

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# Emergency Production of Steel Castings

For many years there has been continuous search, more recently spurred on by the war, to find a rapid, simple, and inexpensive method for producing high-grade steel castings, irrespective of size or intricacy of shape when foundry facilities are either unavailable or overcrowded.

As a result of considerable research, the Metal and Thermit Corporation has developed a special type of thermit, called "Thermicast," for making these castings.

The new process is based upon the well-known reaction of thermit and requires neither fuel nor a source of electrical power to produce the castings. Most of the equipment can be improvised, while production of steel castings by the new method requires little experience. The steel produced with Thermicast meets the tensile-strength requirements for U. S. Navy Class "B" steel for castings.

The thermit reaction is carried out in a conical-shaped crucible which consists simply of a sheet steel shell lined with a refractory material. Two sizes of crucibles have been developed for this special casting work holding 75 lb and 400 lb gross weight of Thermicast, respectively. The crucibles are completely lined and ready to use.

The reaction crucible is first supported by a tripod, platform, or an overhead crane so that the molten material from it will pour directly into a receiving ladle.

A replaceable refractory orifice is next inserted in the crucible stone and plugged with a tapping pin, the whole then being covered with a level quantity of plugging material. The crucible is next charged with Thermicast material, essentially a mixture of aluminum and iron oxide.

Removal of the molten metal is from the bottom of the crucible.—Robert T. Brown, *The Frontier*, Armour Research Foundation, September, 1945.

# *The Third Report of the* NATIONAL PATENT PLANNING COMMISSION

By A. A. POTTER

EXECUTIVE DIRECTOR, NATIONAL PATENT PLANNING COMMISSION

THE third and last report of the Commission, dated June 5, 1945, is mainly a résumé of recommendations which have already been made for the information of the President and Congress in the first two reports.

It is the Commission's conviction that this recognition of the exclusive ownership of intellectual property has fully realized the intent of the Constitution on behalf of the public and should be continued. The principle being sound, the fact that it is at least as old as this Government, as indeed are most of our fundamental institutions, is of no moment. The Commission accepts and believes in the continuation of the view, which has been expressed and approved by the Supreme Court, that when the Government grants letters patent for a new invention it confers upon the patentee an exclusive property in the patented invention.

The Commission has rejected those proposals for revision of our patent system involving a departure from the principles upon which it is founded and by the effectuation of which it has furthered the nation's industrial and social improvement.

In its first report the Commission submitted constructive suggestions for improvements in the procedures of the system and for the elimination of abuses. None of the changes advocated contemplate any departure from the basic principles of the system. Their aim in the interest of public benefit was to preserve its intrinsic good by correcting incidental evils. The Commission now urges that those recommendations be carefully appraised and, in default of any more effective recourse, that they be adopted.

While appreciating the fact that patents, like other forms of property, are susceptible of misuse, the Commission feels that the prevention or penalization of such wrongful use should not jeopardize the patent itself nor incur a departure from the sound principle of patent protection. With the purpose of exposing any and all abuses of patents and to bring about more readily and effectually the correction or elimination of such evils, the Commission has recommended that all contracts relating to patents be publicly recorded in the United States Patent Office.

Another needful and beneficial improvement in the system, and one designed to foreclose the long pendency of an application for patent as a means of extending its effectiveness beyond the period fixed by statute, has been proposed by the Commission in its first report and is again recommended. It is that the term of a patent shall not extend beyond twenty years from the date of the filing of an application.

The third report calls attention to the Commission's previous recommendation in the first report for the simplification of appellate procedure. At present, when the Patent Office denies the grant of a patent, the applicant has avenues of recourse to either of two courts. The Commission has recommended that the United States Court of Customs and Patent Appeals be designated as the sole tribunal having authority to review the decisions of the Patent Office in refusing the issuance of patents.

As a measure to aid in the protection of the public interest, the Commission also recommended that opportunity be accorded any member of the public to challenge the validity of a patent by a proceeding begun within six months after its grant.

The Commission recommended, additionally, the creation of a public register of patents, the owners of which are willing to grant licenses, with power in the Commissioner of Patents to fix the terms in case of dispute.

The Commission is again, and in the national interest, moved to reject the proposal for the general compulsory licensing of patents. That policy and practice would not only nullify the patent owner's proprietorship, but it would also discourage inventiveness and lessen the initiative of investors by exposing them to greater uncertainty and larger risks in the investment of capital requisite to the development and commercialization of new mechanisms and compositions. In the postwar era inventions will be powerful aids to small enterprises, both as to the products and the means of manufacture. Many of such lesser producers owe both their existence and their continuance to patented mechanisms and compositions. If they were obliged to license to others—including their largest rivals—the use of the inventions covering their instrumentalities and their articles of manufacture, their status would be endangered and competition benefiting the public would likewise be hazarded. Even our greatest industries had small beginnings and their growth is surely not in itself a detriment to our national welfare.

As the creation of a new committee, by direction of the President, is interpreted by the National Patent Planning Commission as a discharge from its further obligations under the directions of Executive Order 8977, it has accordingly brought its work to a close with this report.

SKY LINE OF LOWER MANHATTAN FROM BROOKLYN, N. Y.

(For program of A.S.M.E. Annual Meeting, Nov. 26–29, see pages 769–773.)

# FISCAL REQUIREMENTS IN 1949[1]

By DONALD S. TUCKER

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

MUCH of the recent literature in the field of public finance has been written in order to advocate a program. It is therefore a pleasant relief to find a book that advocates no remedies, especially if this book is also so dispassionately written that after perusal a reader is still in doubt with respect to the political sympathies of its authors. Such a book is the recent volume prepared under the auspices of the Brookings Institution.[2] This volume makes no examination of government revenues; it attempts only to measure the need for revenue. Estimates of three kinds are presented for each type of expenditure: a maximum, a minimum, and an intermediate or "probable" amount.

### THE BASIS USED

Certain assumptions were of course necessary for the construction of these estimates. The most important assumptions used in this instance were as follows: (1) The general price level of 1949 was assumed to be no higher than that of 1943-1944. (2) The percentage of the civilian population employed by government in 1949 was assumed to remain substantially unchanged—or at least to suffer no sharp increase. (3) The Japanese war was assumed to last into 1946. (4) The year 1949 was assumed to be one of substantially full employment.

Government expenditures are, of course, not identical with expenses. When a city borrows money and buys a local electric-lighting plant, it makes an expenditure which is not expense. At some later time, when this city retires its debt, it makes another expenditure that is not expense. These facts do not, however, imply that expenditures are necessarily greater than expenses. Accruals of liability under the Social Security Act represent expenses which do not result in immediate disbursements, and there are other items of a similar nature. No estimate of government expenses is presented in the Brookings study. It considers only probable government expenditure.

Duplicating items arising in connection with grants are, however, eliminated. The federal government, for example, is expected to grant about 500 million dollars to the states for highway development, and the states in turn are expected to grant about 340 millions to their local subdivisions for the same purpose. In all such instances a grant by the higher authority is treated as a subtraction from the expenditures of the lower. Expenditures are assigned to the branch of government that must provide the money, rather than to the unit which disburses the proceeds. The purpose of this study is to measure "as accurately as possible the magnitude of the financial obligations that are being assumed and accumulated."

### TOTAL EXPENDITURES

Exclusive of the social-security system, the minimum total expenditure for 1949 is estimated at 29.3 billion dollars. The maximum is set at 37.8 billions, and the probable expenditure at 33.5 billion dollars. On some individual items the deviation of the maximum or the minimum from the "probable" estimate is large; but all the figures in this book are necessarily estimates only. It will be convenient therefore in subsequent paragraphs to consider only the estimate which the authors regard as "probable."

Out of a probable total expenditure of 33.5 billions, it is expected that the federal government will in 1949 spend 22.3 billions. State governments will spend perhaps 4.4 billion dollars, and local units about 6.8. The federal government therefore will spend almost precisely two thirds of this huge total, if social-security finances are omitted from consideration.

Social-security finances deserve special treatment because in this field the government's receipts will presumably exceed its relief expenditures by nearly two billion dollars, if 1949 proves to be a year of reasonably full employment. At first glance it might seem that these two billions could be treated as a revenue or at least as a deduction from the federal government's other fiscal requirements; but there are objections to such treatment in this instance. These receipts belong in a trust fund. This trust fund's liabilities are accruing at least as rapidly as its assets. Legislation directs that these receipts shall be invested in designated government securities. Purchase of these securities does reduce the outstanding public debt, and such purchases may therefore perhaps be regarded as debt retirement; but even debt retirement entails expenditure. The prospective need to purchase two billion dollars worth of bonds should for this reason be included among the federal government's financial requirements. This item differs from other expenditures in only one respect: We know in advance the precise tax by which this disbursement will be financed. Such foreknowledge may perhaps diminish the psychological burden of the tax; but it does nothing to diminish the financial burden. If the Fund's need to purchase government bonds is now included among government fiscal requirements, the total requirements of our federal government in 1949 become 24.3 billions and the total requirements of all branches of government become 35.4 billion dollars, even if there is no formal debt retirement.

Out of 35.4 billions then, more than 1.9 billion dollars will be spent, probably for government bonds. In examining the purposes for which the remainder of this sum will be spent, it will be convenient to refer to any item less than 350 million dollars as "small" and any item less than 35 millions as "negligible." In a combined budget exceeding 35 billions an item of only 350 million dollars is less than one per cent of the total, and 35 million is less than one tenth of one per cent. Only by using some fiction is it possible to retain a sense of proportion when dealing with sums of such staggering magnitude.

### SPECIFIC APPROPRIATIONS

National defense, as might be expected, constitutes both the largest element in the federal budget and also the largest element in the combined total. Whether or not we adopt peacetime conscription will apparently make very little difference in the total spent for this purpose. In any case the Army will probably contain between 750,000 and 1,000,000 men, and the Navy from 650,000 to 1,000,000. Total military personnel will be not far from 1.7 million men. For purposes other than compensation the Army will require about $2500 per soldier, and the Navy will need about $3400 per sailor. With all elements included, the probable expenditure for defense will be about 7.8 billion dollars. Veterans' benefits, it is expected, will add about 2.9 billions of direct costs, so that disbursements for military functions will display probably a total of about 10.7 billion dollars. In 1940 these military expenditures were less than one fifth of this sum.

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[1] One of a series of reviews of current economic literature affecting engineering prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

[2] "Post-War Fiscal Requirements, Federal, State, and Local," by Lewis H. Kimmel and Associates, the Brookings Institution, Washington, D. C., 1945.

Regulative and protective functions include police and fire protection. For this reason about 70 per cent of this expenditure will be borne by local governments. Total costs of this type for all branches of government in 1949 are estimated at 1.3 billion dollars or about 4 per cent of the total expenditure.

In 1944 the per capita consumption of agricultural products by the civilian population was about 9 per cent higher than the average for the years 1935–1939. Will civilian consumption after the war remain at this high level? In the case of agricultural products a small change in the quantity demanded means often a relatively large change in the price. The chief federal program in connection with agriculture is one of price support. An estimate of the cost of the parity-price program is therefore peculiarly difficult; but a disbursement of 2050 million dollars is regarded as probable. The soil-conservation program and other elements will bring aids to agriculture up to a probable total of 2.7 billions. For highways the states will spend 1.1 billions of their own funds and towns will add almost another billion. Aids to aviation and other elements will bring the total expenditure on transportation up to 2.9 billions. If now the development of natural resources (655 millions) and the negligible expenditures for labor, commerce, and industry are added to these expenditures for agriculture and transportation, the total spent on the promotion of economic development will become approximately 6.3 billion dollars.

For education the states will spend 1.5 billion dollars—chiefly in grants to local governments. These local units will add 2 billion dollars of their own funds. A small sum will be added by the federal government, so that expenditures for schools of all kinds will probably total about 3.6 billion dollars. For public assistance of various kinds the federal government will presumably spend about 765 million dollars, the states from their own resources will spend approximately one billion, and the towns will add another 570 millions, so that government expenditures for public assistance will probably total about 2.3 billion dollars. Public health and sanitation (chiefly garbage removal even if an enlarged public-health program is adopted) will cost perhaps 620 millions. Public recreation, housing, and the administration of the social-security system will each take small amounts so that total expenditures for the promotion of social welfare will perhaps amount to 7.1 billions.

In computing interest on the public debt it was assumed that the federal debt will increase for several years after the close of hostilities and that the current decline in state and local debts will be arrested. Interest payments will be increased chiefly by the substitution of long-term securities (which bear higher rates of interest) for the present short-term obligations; but there may be also some slight stiffening of the general market rate of interest. Total interest requirements are therefore estimated at 5.6 billion dollars. In 1940 debt service required only about one fourth of this sum.

General government includes foreign relations as well as legislative, executive, and judicial functions. Federal expenditures for such purposes are estimated at 451 millions, state disbursements at 210 millions, and local expenditures at 750 millions, giving a total of 1.4 billions or about 4 per cent of the total expenditure.

Governmental business enterprises, federal, state, and local, will require perhaps 380 million dollars—chiefly for capital purposes. Other causes of expenditure are fairly numerous. Though all of these other items are either "small" or "negligible" in size, the combined total of such items is 693 millions. If, now, business enterprises are added to this miscellaneous group, the unclassified expenditures of all branches of government will approximate 1.1 billion dollars.

### THE BURDEN

In 1940 the national income was 76 billion dollars. Total fiscal requirements, including social security, were then 18 billions. Fiscal requirements were therefore 23.7 per cent of the national income of that year. For 1949 the estimated income is 130 billions. Total fiscal requirements (social security; federal, state, and local) may be 35.5 billions. Government requirements may therefore be 27.3 per cent of the national income of 1949. Comparison of these two percentages (27.3 against 23.7) is admittedly fairer than a comparison of dollar amounts; but no amount of rationalization can make the increase of burden seem pleasant. The Civil War and World War I were each followed by a great upward leap of governmental expenditures. It seems inevitable now that World War II will have a similar aftermath.

Expenditures for the promotion of social welfare are expected to diminish from 7.3 billions in 1940 to 7.1 in 1949. Other expenditures of many kinds are expected to increase only very moderately. Total expenditure, however, will expand by 16.1 billions. One fourth (4.1 billion dollars) of this increase will be associated with interest on the public debt. More than half (8.6 billion dollars) of the increase will arise in connection with the enlargement of our military functions. Less than one fourth of the entire increase will be due to all other causes combined. Three fourths (12.9 billions) of the increase will therefore be associated directly with war. If the dollar amount spent for military and interest requirements in 1949 were identical with that of 1940, the ratio of government expenditures to the national income would decrease from 23.7 per cent (1940) to 17.4 (1949) provided the national income could be maintained at 130 billions in the absence of these payments by government. If fiscal requirements and the national income of 1949 were both reduced by just 12.9 billion dollars, the appropriate figures would be 23.7 per cent in 1940 and 19.3 per cent in 1949. Though many of us may feel that certain types of nonmilitary expenditure were excessive in 1940, the increase expected between 1940 and 1949 for all purposes other than war is certainly moderate indeed. The enormous burden of our anticipated military expenditures will apparently result in a rigid curtailment of all other government functions. Exclusive of veterans' benefits and interest requirements, our direct expenditures for defense were only 1.5 billion dollars in 1940 when war was already raging in Europe; but defense expenditures are expected to amount to 7.8 billions in 1949.

*Cushing, N. Y.*

AT THE EARLY MORNING MARKET IN NEW YORK CITY

(For Program of 1945 A.S.M.E. Annual Meeting, Nov. 26–29, see pages 769–773.)

# BRIEFING THE RECORD

## Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotations marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

## Requirements

ENGINEERING education is constantly providing evidences of a passion for self-appraisal and soul-searching analysis of its aims and achievements. Shortly after World War I the monumental study conducted by the Society for the Promotion of Engineering Education set a high standard of excellence and thoroughness and profoundly influenced curricula, faculties, and student bodies throughout the years which have followed. The names of Scott, Wickenden, and Hammond are indissolubly associated with this study and the beneficial results that grew out of it. Not to be forgotten is the Carnegie Foundation with headquarters in New York which provided funds, encouragement, and advice as indeed it continues to do today. Engineering societies also were wholeheartedly behind the project and the resurgence of engineering education that resulted from it. Nor was industry backward in its support. The late Robert I. Rees is gratefully remembered as are many personnel officers and industrialists. Co-operation of the colleges and the industries brought the two into close contact with mutually beneficial results in understanding and greater educational opportunities. Training programs in industry were closely co-ordinated with those of the engineering schools. Co-operative education, under the vigorous stimulus provided by the late Herman Schneider, showed how industry could serve as an adjunct to the facilities of the schools, and opportunities for special and postgraduate courses were developed. One thinks of D. C. Jackson as an early proponent of this trend and of R. L. Doherty, more recently, as an engineer turned college president who powerfully influences the advances of ideals of education in both its scientific-technical and its social economic stems. Education and training within industry also progressed during this era. The programs set up by a majority of our large industrial concerns have come into maturity and are advanced, in some cases, to the degree-granting stage. Nor has the financial support of education by those who use the products of the colleges been neglected. Scholarships and fellowships are being established with liberality and sound purpose and in most cases without obligating the beneficiaries to take employment with the donor companies. During this period too the Engineers' Council for Professional Development launched its fourfold program of student selection and guidance, of accrediting engineering curricula, of the development of the young engineer entering the profession, and of the recognition of attainment, emphasis on professional unity and ethics, and influencing the public's esteem of the profession. These brief high lights afford evidence of the powerful influences on engineering education that have been at work during the last quarter century and indicate the real concern of everyone connected with the profession over improvement of the quality of engineering-school graduates.

A few months ago MECHANICAL ENGINEERING presented a "reply" from the industries to the engineering schools in which Boring, Stevenson, and MacEachron of the General Electric Company offered some pertinent and penetrating comments. In *Civil Engineering* for September, F. N. Pearce, of Northern Montana College, analyzes the results of a questionnaire sent to members of civil-engineering firms, highway-engineering departments, railroads, city and governmental departments, for the purpose of establishing a guide to planning the civil-engineering curriculum and objectives of an engineering college. Neglecting the portions of the report which deal specifically with civil engineering leaves a useful residue of conclusions that are generally applicable to all engineering education. Professor Pearce summarizes the comments received as follows:

"Higher prerequisites for admission should prevail, with more careful selection of students. The period of training should be increased to five years, during which time the general objective should be to train for leadership. Originality and resourcefulness should be encouraged because these attributes, along with perspective and energy, are essential. Accuracy, thoroughness, and neatness should be drilled into students. Greater confidence in ability should be instilled with accent on training in how to find needed information and use it properly. Memorizing is then relatively unimportant.

"During college, intensive and thorough training should be given in basic sciences—mathematics, chemistry, physics, and mechanics...... Skill in reading and interpreting engineering drawings is fundamental. No instructor should be permitted to load his particular course to the point that proper time cannot be given to other equally important courses.....

"An engineer is something more than a technician. Therefore, it was recommended by many employers that cultural courses be included in the curriculum. More emphasis should be placed on English, public speaking, and composition, including report writing. There should be courses in logic, economics, finance, government, history, geology, sociology, and law. A seminar or orientation class should discuss such topics as job interviews, supervision of men, ethics, character, public relations, licensing, and professional development after college.

"Class work can be made more practical by having practicing engineers lecture in co-ordination with assigned problems similar to those encountered in practice. Instructors should have a background of practical engineering experience. Consideration should also be given to the use of training films and training devices similar to those adopted by the Armed Forces and proved to be very instructive.

"Many of the men who have been most successful are most insistent that students realize that real training begins when one leaves school. Men should be encouraged to undertake postgraduate studies, read technical publications, and develop a professional attitude. Civil engineers would fare better if they would take a more tolerant attitude toward refinement and culture and extend their influence in community, social, and professional organizations."

## Branch Plants

A MEMBER of the A.S.M.E., a graduate of Yale and Harvard, Graham Woodward Parker, consulting engineer of New York, has sent us a pamphlet copy of an interesting paper, "The Branch Plant Trend in Industry."

Mr. Parker reviews three broad movements in the economic world of today that he says are acquiring increasing force as peacetime planning reaches reality. There is first the trend of American exporting—export of technology; next the doctrine of regional deficiencies; and finally the branch-plant movement in industry, "the technical support of the first two."

Export of technology has been going on for many years, beginning with shipments of production equipment and developing into the sending of the American engineer abroad instead of sending the machine, and later expanding into the export of American management . . . . "the American manager who went over to direct a foreign branch office or subsidiary of the home company and the consultant who went abroad to introduce American management methods in European companies." "The latest, or at least, the most striking aspect of the export of technology," Mr. Parker asserts, "is the 'packaged plant.'"

The "deficiency doctrine," writes Mr. Parker, "will be recognized, of course, as only another phase of that movement which was somewhat threatening in the 30's wherein the individual state erected invisible obstacles to interstate trade in the form of trucking laws, inspection of agricultural produce, and petty taxes.

In a small way, the whole movement was a domestic parallel of the moves toward greater industrial autonomy that were going on in most foreign countries. One of the first possible postwar effects will be an increased revival of the latter development and similarly, it is quite likely that there will be an equivalent intensified competition between our states, or at least between our several economic regions."

This brings Mr. Parker to the branch plant which is "the element which renders practical in a technical way both the export of technology and the growth of regional industry." Examples are given of American manufacturing firms that more than a quarter century ago found it practical to establish complete branch plants in their foreign markets, and attention is directed to the announced intention of one company to establish smaller plants in smaller communities in various parts of the country where costs will be as low as in the older plants. The Pacific Northwest is cited as an example of a region, with cheap power, where there is a "strong movement for the establishment of local small industries, preferably in the agricultural towns, to serve as a balancing element in the economy of the community." The outline of a possible engineering program for such a development is given.

The practicability of branch-plant production has increased hand in hand with the development of the automatic precision machine, asserts Mr. Parker and "much credit for the decentralization of industry must be given to the American machine designers and builders who have sought to integrate in compact automatic units the advantages of low-cost production. Credit must also be given to our progress in standardizing and disseminating a concrete body of management methods—the production control, storeskeeping, cost accounting, operations analysis—which have made it possible for the branch plant in Oklahoma or in Brazil to be administered as efficiently as a mother plant in Detroit."

"As for the future," he concludes, "we may expect that the next ten years will see a more equal distribution of manufacturing throughout the United States and an abundance of manufactured product that we have never known before, while in the foreign field American manufacturing methods, through American machines, American engineers, and direct investments, will cover the world economy even more thoroughly than did the nineteenth-century mercantile methods. We may be confident that branch-plant methods, both mechanical and administrative, will continue to develop into a well-rounded, distinctive arm of our American production science, and will bring ample benefits to the economy of communities throughout our country."

# Blind-Hole Tapping

PRODUCTION engineers who have met with trouble in tapping blind holes will be interested in a new procedure known as cartridge tapping. A plastic plug, or cartridge, is inserted into the drilled hole and the pressure of the tap as it feeds into the hole causes this plastic to flow outward in the flutes of the tap, removing the chips which are embedded in it.

A study of the difficulties encountered in obtaining a perfect thread by means of a tap and of lubricating the tap properly, pointed to the chips formed during tapping as the principal cause. Chips wedged in the lands of a tap produce extra power requirements, torn threads, and broken taps while cutting. When backing the tap out of a hole the cutting edges drag over the work, with the result that the cutting edges become loaded and chips become wedged in the relief spaces. Besides the breakage of the cutting edge and even the tap itself this action contributes to excessive tap wear, tearing of threads, and tapered pitch diameter.

For the sake of illustration a hole was drilled and tapped in a block of Plexiglas, Fig. 1. The blind hole *A* receives a loosely fitting cartridge *B*. The pressure of the tap upsets the cartridge to fill the hole, and as the tap threads the hole *C*, the plastic flows outward in the tap flutes carrying the chips with it. Since all chips are removed no clearance is required at the bottom of the hole and the thread can be cut the full length, *D*. A smooth and perfect thread *E* is formed.

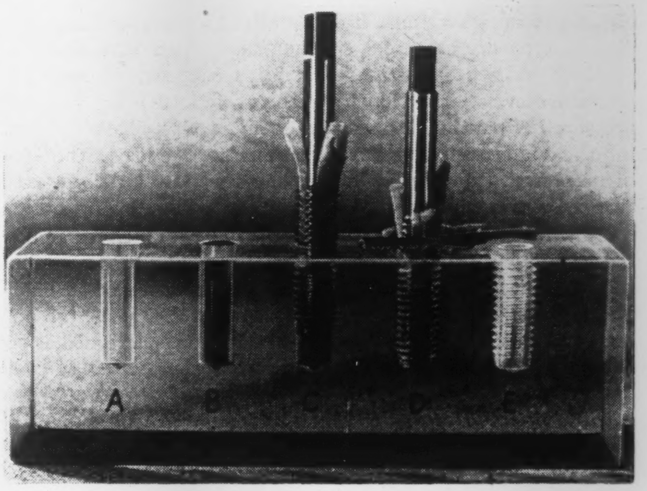


FIG. 1 VARIOUS STAGES OF PROCESS OF CARTRIDGE TAPPING

The tap cartridge can also be used for through holes by backing the workpiece with a plate recessed to receive the end of the tap. In this case the cartridge must fill both the recess and the drilled hole.

Tap-Cartridge, Inc., state that when tapping materials for which a lubricant is required, capillary attraction will draw sufficient lubrication to the cutting edges to insure smooth cutting.

# Gas Turbines

THE Allis Chalmers publication "Annual Review" offers the following comments on the gas turbine for marine and land use:

"Moderate thermal efficiency and low relative cost make the basic gas-turbine cycle an immediately promising 'peak knocker' on electric power systems, where intermittent operation would justify its use. Modifications of the basic cycle comprising intercooling, reheating, and regeneration are capable of producing thermal efficiencies comparable with those of modern steam power plants. However, before such cycles could be justified economically for general base-load operation in central-station practice, it will probably be necessary to resort to the use of pulverized coal. The difference in cost between coal and oil offers a real incentive for the employment of solid fuel. Experiments with pulverized coal for gas turbines are promising, but certain problems still have to be solved before a satisfactory coal-burning unit is obtained.

"Soon to materialize is a gas turbine for ship propulsion. Experimental units are being designed for merchant vessels, where essentially constant-load characteristics ideally suit them to the gas turbine. The problem of astern operation with gear drive is more acute in the case of the gas turbine, since, unlike the steam turbine, it normally exhausts at atmospheric pressure. As a result, the gas turbine requires a separate vacuum system to provide a low-density atmosphere in which to rotate the astern and ahead turbines during forward and reverse operation, respectively, to prevent prohibitive windage losses. The reversing problem could be diminished by the use of electric drive or a variable-pitch propeller which would eliminate the use of separate astern turbines.

"A new gas-turbine experimental unit includes several innovations in gas-turbine design. First, a heat exchanger is provided to decrease fuel consumption when ultimately applied to ship propulsion. Secondly, the turbine supplying the power was separated from the turbine driving the compressor. A parallel turbine arrangement was adopted, allowing the compressor and driving turbine to operate at the speed of maximum efficiency and allowing the power turbine to be stopped while the compressor turbine was still in operation.

"The mechanical design of each turbine provided for an overhung spindle consisting of two stages of impulse blades attached to the spindle by welding and three stages of reaction blades. Special alloys are used for all critical parts. The high inlet temperature of 1500 F, for which this turbine is designed, is considered to offer attractive possibilities for increased efficiency and reduced weight when applied commercially to many gas-turbine installations including the marine field.

"Possible use of pulverized coal for fuel is being developed on the basis of combustion tests conducted under gas-turbine combustion-chamber conditions. The combustion problem was solved satisfactorily, but some erosion troubles were encountered. Subsequent tests of the resistance of specimens of various materials to erosion of ash-laden high-temperature air have shown promising results."

## Sectional Carbide Molds

AFTER six years of experimentation, the Firth-Sterling Steel Company has announced that sectional carbide nib molds show definite advantages in the field of powdered metallurgy over the solid mold. An increase is claimed to have been made by their use of from seven to ten times the production obtained with solid-steel molds. The experiments were carried out in a group of industrial plants and so represent actual operating conditions.

A plant, in which tungsten-silver electrical contacts were formed, used pressures of from 60 to 70 tons and obtained from 27,000 to 124,000 units with a wear of less than 0.001 in. on the mold. As the tolerance on the contacts was 0.005 in., it was estimated that 500,000 of these contacts could be formed before the nib needed regrinding. It was further estimated that five recuts could be made, giving a production life of 2,500,000 units for the mold. This assumption has been justified by results from other plants.

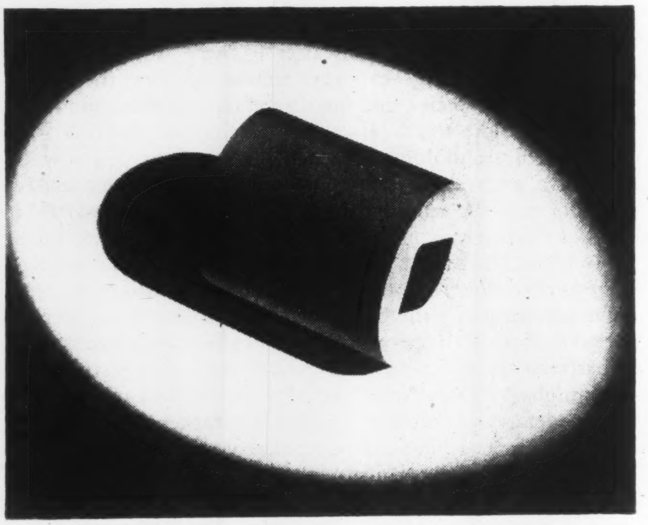


FIG. 2 SECTIONAL CARBIDE NIB MOLD

The use of sectional nibs provides "controlled cracks" at sharp corners, as shown in Fig. 2, and relieves the stresses at these points that otherwise would cause failure by fatigue, resulting in cracking and chipping.

A big advantage claimed for the sectional nibs is the possibility of recutting them a number of times to the original size for long production runs. Also, a sectional nib may be recut to a larger size which will, it is estimated, reduce mold costs by about one third.

## Surface-Finish Analyzer

ACCORDING to the British Information Services there has been developed in Great Britain a new precision instrument, the "P.V.E." surface-finish analyzer. This instrument, designed for visual use, incorporates in one unit a light source, an optical system, and a reference lens. By means of this, use is made of the interference of fringes of light for producing a series of bands which follow exactly minute differences present on the surface under test, these bands being in effect a number of highly magnified pictures of the surface contours. The method is said to insure absolute accuracy of surface measurement, any possible errors due to mechanical and electrical effects being eliminated. The instrument is now being made in two variations. The first is for visual operation only. With the second, records can be made by means of a photographic attachment. One of the advantages claimed for the surface analyzer is that, being portable, it can be taken to the job and even rested on the article under examination.

## Atomic By-Products

WHILE public attention has been directed to the unbelievable destructive effects of the atomic bomb and, in consequence, on the military, political, and ethical problems involved, and while engineers have been quick to grasp the significance of atomic energy as a possible new source of power, little has been said of the many by-products of the research and developments connected with the project that will have almost immediate repercussions in engineering. These are the by-products which are happily disassociated from the military, political, and ethical questions, and their uses are of great peacetime value with constructive, rather than destructive, application.

The immediate benefits to American industry in new inventions, new and improved products and procedures of manufacture resulting from the atomic-bomb project were made public at a luncheon, held at the Biltmore Hotel, New York, N. Y., on September 16 under the auspices of The M. W. Kellogg Company. The Kellogg Company arranged the meeting on behalf of its wartime subsidiary, The Kellex Corporation, a noncommercial industry-wide unit which engineered through to construction and operation one of the major plants of the atomic-bomb project at Oak Ridge, Tenn.

The keynote of the meeting was the promise, based on current estimates, that, as a result of the development work underlying the project, more than 5000 new products and procedures affecting all phases of American life are available to industry. These products and procedures now await only Government release for commercial application.

Arranged on authorization of the War Department, the meeting included addresses by H. R. Austin, member A.S.M.E., executive vice-president of The Kellogg Company, and A. L. Baker, member A.S.M.E., general manager of The Kellex Corporation. The Kellex Corporation was formed for the purpose of developing procedure and designing equipment for volume production of uranium 235, an essential ingredient in the atomic-bomb project. From a memorandum distributed at the luncheon certain portions are quoted in what follows.

### INDUSTRIES THAT WILL BENEFIT

Some of the industries which will benefit from the developments and the general nature of the benefits to be derived are as follows:

1 *Petroleum refining*
  - (*a*) Improved pumping.
  - (*b*) New type, more efficient heat exchangers.
  - (*c*) Mass spectroscope (continuous analytical control).
  - (*d*) Possible new methods of separating gasoline fractions.
  - (*e*) Improved automatic control.

2 *General chemical and processing industries.*
  Same as in petroleum refining.

3 *Manufacture of pressure and vacuum vessels.*
  - (*a*) Checking welds.
  - (*b*) Pretesting vessels for leaks before operation.
  - (*c*) Improved vacuum techniques.

4 *High-vacuum industries.*
  - (*a*) Improved vacuum methods for vitamin distillation.
  - (*b*) New methods of detecting high vacua in electronic-tube manufacture.
  - (*c*) Low-pressure, low-temperature dehydration of foodstuffs.

5 *Gas processing industries.*
  - (*a*) Diffusional separation of helium from natural gas.
  - (*b*) Efficient separation of hydrogen from process gases.
  - (*c*) Diffusional separation of oxygen and rare gases from air.
  - (*d*) New techniques in gas recycling.

6 *Electrical industry.*
  - (*a*) New electronic techniques in high vacua.
  - (*b*) Improved microsensitive instrumentation.

7 *Medical profession.*
  - (*a*) A low-cost, more abundant source of radioactivity.
  - (*b*) Improved protective methods for combating toxicity in industry.
  - (*c*) Extension of cancer therapy.

8 *Refrigeration industry.*
  - (*a*) Increased safety in equipment.
  - (*b*) Improved handling of fluorides for refrigerants.

9 *Industries employing corrosive chemicals.*
  - (*a*) New pump and valve lubricants and packing methods.
  - (*b*) New treatment of metal surfaces to prevent corrosion.
  - (*c*) Improved safety practices.
  - (*d*) Completely enclosed pumps operated from exterior by induction.

### CORROSION FACTORS

Right from the start of the project staggering obstacles loomed. Uranium, being a solid, had first to be transformed into a gas for utility in the selected gas-diffusion process. This meant selecting a compound of uranium with some other element which would be gaseous at nominal temperatures and from which elemental uranium could be readily regained after diffusion. After much experimentation, which included uranium hexafluoride, $UF_6$, and also other gases, suitable process gases were selected. One of the big advantages of $UF_6$, which brought it into special consideration, was that fluorine, having only one isotope, would not complicate the separation by adding new combinations which would diffuse at varying speeds. Uranium hexafluoride is a solid at room temperature but fortunately turns into a gas at 56 C. Unfortunately, however, like most fluorine compounds, it was highly reactive, physiologically poisonous, and it introduced problems of corrosion which pointed toward difficulties in production and handling. In the words of one Kellex spokesman "uranium hexafluoride is one of the hardest things to handle in the history of mankind."

It was found that practically all the techniques and developments gained in the successful study of the problem could be carried over into a number of industries plagued by corrosion factors through improvement in equipment and processing. The results indicated a saving of millions of dollars annually in the conservation of critical equipment and materials, minimum breakdown of moving parts, and also increased safety for workers.

In the process it was imperative that no material in contact with the process gas react with it since such corrosion would lead not only to plugging of the microscopic pores of the diffusion barrier and various mechanical failures but also to absorption (i.e. virtual disappearance) of enriched U-235 isotope. Obviously, therefore, standard-type valves and piping could not be used; instead, new methods of pretreating metal surfaces against corrosion were worked out, new coolants, piping, new-type heat exchangers, lubricants, pumps, and packing were developed to satisfy the stringent requirements.

Hydrogen fluoride is an important isomerization and alkylation catalyst in petroleum refining as well as an important raw material in the production of aluminum and refrigerants. It is, however, so highly active and dangerous that industry has not yet capitalized on many of its potentialities. Its handling may now be made safer and simpler without excessive maintenance costs and as a result its increased use in industry may be realized.

Other important starting materials for a host of industrial products such as sulphur dioxide, hydrogen chloride, and the mineral acids (sulphuric, nitric, and phosphoric) have all presented severe problems of transfer and corrosion with particular emphasis on valve lubricants and pump packings. These difficulties can be greatly simplified by application of the knowledge gained through the extensive experimentation with $UF_6$ and the other related gases.

### PUMPS

The story on pumps, the heart of the process and one of its most difficult problems, is particularly interesting and applicable to modern industry. Thousands of pumps operating under reduced pressure at Oak Ridge created problems in vacuum technique on an unheard of scale. Other thousands operated at nominal pressures. But regardless of the type or service none could leak or corrode and all had to have as small a volume as possible. Many different types of centrifugal blower pumps and sylphon-sealed reciprocating pumps were tried out and new types developed. For example, in one of the pumps for the larger stages the impeller was driven through a coupling containing a very novel and ingenious new seal. Another type of pump was completely enclosed, its centrifugal impeller and rotor being run from the outside by induction.

Top-flight pump designers from leading manufacturers in this country collaborated in research at the central Kellex laboratories in Jersey City and succeeded to a remarkable degree in increasing industry's knowledge of this all-important phase of processing. For security reasons the practical applications of the new types of pumps developed cannot yet be revealed publicly. However, the engineers who participated in this phase of the project have brought to their parent companies a vastly increased lore of new techniques which cannot help but be reflected in increased service to their customers.

Perhaps the most significant advance in pump design which has been most successfully accomplished is the utilization of supersonic velocities of a very high order (Mach numbers of over 1.0).

### BARRIER REQUIREMENTS

Literally acres of porous barriers were required for the gas-diffusion plant with billions of holes smaller than about two millionths of an inch. Despite the high degree of porosity required such barriers had to be able to withstand a pressure head of one atmosphere. The pores had to be of uniform size and spacing, must not become enlarged or plugged up as the result of direct corrosion or dust coming from corrosion elsewhere in the system, and the barriers had to be amenable to manufacture in large quantities and with uniform quality.

One of the major reasons for the lack of diffusion techniques in industry today has been the barrier problem. Few, if any, corporations cared to expend the prohibitive time and money in the necessary research on this problem, until it was made necessary by the exigency of the situation. Almost at the last minute an excellent barrier was developed and today these operate successfully throughout the more than several thousand stages.

### APPLICATION OF DIFFUSION PRINCIPLES

Now that a large part of the basic research on diffusion barriers and their application to full-scale industrial separations has been completed, particularly with reference to gas recycling and instrumentation, it seems almost certain that helium will be separated from natural gas by diffusion techniques rather than by the present refrigeration method. Helium is so light in comparison to other components of natural gas that its diffusion velocity through a porous barrier is over twice as great as the next lightest compound present in the same source.

It may be even easier to isolate hydrogen by these new methods from a number of process gases now used merely as fuel because the diffusion velocity of hydrogen, the lightest of our elements, is over four times that of any compound associated with it.

The isolation of ethylene from cracked gas oil by incorporating diffusion barriers as an integral part of cracking units could conceivably supply an abundant source of this versatile chemical used for the manufacture of synthetic rubber, plastics, antifreeze, alcohol, and many other products.

The preparation of oxygen and rare gases from air without resorting to refrigeration and fractional distillation is another possible application, when economic methods are developed.

The direct isolation of natural-gasoline fractions from crude petroleum without resorting to distillation, and new types of fractionating columns for the petroleum-refining industry also appear feasible.

### INSTRUMENTATION

If pumping is the heart of processing, then instrumentation is the brain. No continuous process could function efficiently without adequate automatic control. In the gaseous diffusion plant the problems of instrumentation were far greater than in any other industry because the theory involved the assumption that diffusion took place through an infinite number of stages whereas practicability dictated that such stages be limited in number.

Even so, several thousand stages were required, necessitating an intricate system of gas recycling involving abnormally large volumes of gases in relation to the finished product and continuous high-precision analytical control. About half of the gas processed in each stage diffused through the porous barrier as enriched U-235 product, and after repressuring was sent on to the next higher stage for further concentration; the impoverished half was also repressured and recycled through the next lower stage. The recycling involved was enormous, over 100,000 times the volume of the final enriched gas.

There were developed to meet these needs the most precise, continuous, automatic, analytical control instruments ever produced by man. This refinement is one of the outstanding features of the gas diffusion plant and constitutes one of its most important applications to industry today. Instruments which before had existed only in research laboratories were improved upon and adapted to commercial use; completely new prototypes were conceived, developed, and put into mass production. The result is that now as never before there is available to industry a more nearly perfect system of continuous automatic control than has ever existed.

### MASS SPECTROSCOPE

One of the developments employed is a new type of mass spectroscope which every petroleum refiner will welcome for control of cracking operations and transfer-line analysis. The mass spectroscope has been employed for several years in research laboratories and even within the last two years in certain phases of the refining industry but never on the perfected scale developed at Oak Ridge. The foremost instrument engineers and physicists in this country and England devoted their full time not only toward gearing this instrument to continuous control but also to expanding this country's capacity for its quantity output. In no other country has electronic research been applied on so grand a scale. Security considerations are not violated in revealing that the mass spectroscope is an electronic device for analyzing gases both qualitatively and quantitatively from a mass standpoint by separating a beam of dissimilar gas molecules into separate beams according to their formula weight. Determinations are very fast, require only a thimbleful of gas, and make obsolete the formerly used Orsat and chemical analyses particularly for the purposes of continuous control where instantaneous changes must be effected the moment a process swings "off the line."

Its potential uses in industry include the accurate analysis of natural gas or any process gas, the continuous automatic control of any gaseous process such as alkylation, dehydrogenation, and vapor-phase cracking, the checking of inert gases such as nitrogen used to provide a protective atmosphere in furnaces, the checking of the completeness of any evacuation process as in the manufacture of radio tubes, the detection of impurities, and many others. Industry will not have to wait for benefits from this versatile tool because production facilities have been enormously increased since the new type was created.

### LEAK DETECTOR

A second development, aptly and simply called "the leak detector," is more sensitive than any other existing device previously utilized for the same purpose. It played an important part in insuring that all parts of the gaseous diffusion plant were vacuum-tight. Any leaks out of or into the system would be damaging both from the standpoint of loss and contamination of an exceedingly valuable material. The leak detector is well adapted for locating annoying leaks in industrial high-vacuum processing industries such as vitamin manufacture where even microscopic leaks undetectable by the familiar ammonia-hydrogen chloride method or Tesla coil method are still potent enough to prevent drawing the necessary high vacuum on the equipment. Other potential uses include the pretesting of pressure and vacuum apparatus before putting it in service, checking equipment in operation to insure no wasteful loss or contamination, the testing of welds for minute pores which would otherwise escape detection, and insuring the physiological safety of refrigeration equipment employing toxic coolants.

### HEAT EXCHANGERS

Of great interest to the petroleum-refining industry is the development of a new type heat exchanger. Since an unavoidable concomitant to pumping gas is heating it and since enormous volumes of gas were processed, individual cooling units for each stage had to be developed. A brand new type of heat exchanger was conceived for this purpose and developed up to the production stage. A manufacturer was then selected and shown how to make it even to the extent of redesigning his equipment so that thousands of units could be turned out quickly. They were installed and functioned very well.

### POSSIBLE MEDICAL AND PHYSIOLOGICAL BENEFITS

Thanks to the variety and multiplicity of radioactive products which can be produced by means of U-235, we face the prospect of soon having available for therapeutic medicine radioactive materials possessing a wide variety of properties. It is logical to expect, therefore, that these new materials will be suitable for products offering a greater range of usefulness, and at lower cost than radium.

The possibility exists of incorporating a micro quantity of a radioactive isotope in food to observe its metabolism in the body of experimental animals. Such "tagged" material could be readily traced in its passage through the organs of the body.

## Definitions

RECENT objection to the definition of professional engineer in the registration law of the State of Illinois has stimulated numerous persons and organizations to attempt the formulation of a more acceptable definition. Among these attempts is one reprinted in *The Registration Bulletin* for September, 1945, of the National Council of State Boards of Engineering Examiners. At a conference of representatives of national engineering organizations, held in New York, N. Y., on Aug. 28, 1945, with W. G. Christy representing The American Society of Mechanical Engineers, definitions of "professional engineer" and "practice of engineering" were adopted. The definitions have yet to win the approval of the governing boards of the organizations represented at the conference, but in view of the interest in the subject they are quoted in what follow:

*Definition—Professional Engineer:*

"The term professional engineer within the meaning and intent of this Act shall mean a person who, by reason of his special knowledge of the mathematical and physical sciences and the principles and methods of enginering analysis and design, acquired by professional education and practical experience, is qualified to practice engineering as hereinafter defined, as attested by his legal registration as a professional engineer.

*Definition—Practice of Engineering:*

"The term practice of engineering within the meaning and intent of this Act shall mean any professional service or creative work requiring engineering education, training, and experience and the application of special knowledge of the mathematical, physical, and engineering sciences to such professional services or creative work as consultation, investigation, evaluation, planning, design, and supervision of construction for the purpose of assuring compliance with specifications and design, in connection with any public or private utilities, structures, buildings, machines, equipment, processes, works, or projects.

"A person shall be construed to practice or offer to practice engineering, within the meaning and intent of this Act, who practices any branch of the profession of engineering; or who, by verbal claim, sign, advertisement, letterhead, card, or in any other way represents himself to be a professional engineer, or through the use of some other title implies that he is a professional engineer; or who holds himself out as able to perform, or who does perform, any engineering service or work or any other professional service designated by the practitioner or recognized by educational authorities as engineering."

Two other definitions which the engineer may wish to add to his scrapbook of quotable statements are less formal than the ones quoted in the foregoing paragraphs. The first of these is by Dean George F. Bateman, of The Cooper Union, a member of A.S.M.E., and a former chairman of the A.S.M.E. Committee on Publications. Dean Bateman's contribution constitutes the opening statement of that excellent and unusual catalog of the institution he serves referred to in our issue of August, 1945, and was written for prospective students and their parents and advisors. Writes Dean Bateman: "Engineering is the art of transforming the resources of Nature for the use of man, by considering wisely all the factors entering into the operation. The principal factors are the physical, the financial, the legal, and the social. Generally speaking engineering work may be divided into the following divisions: design, production or construction, inspection and testing, operating and management, application and sales, research and development."

The second of these newer "definitions" was given by A. S. Moxon, chairman of the Rochester Section, A.S.M.E., at a recent conference of A.S.M.E. section delegates of Group III at Schenectady, N. Y. According to Mr. Moxon, the designation "engineer" applies to "persons possessing an intimate knowledge of mathematics and physical sciences, gained by technological and scientific education, training, and experience, and in a position of trust and responsibility, who apply their knowledge in controlling and converting forces and materials to use in structures, machines, and products, and whose work requires the exercise of discretion and judgment, is creative, and o such character that the output cannot be standardized."

## Sawdust

A PROCESS for producing wallboard and similar products from sawdust was recently demonstrated by Dr. Donald F. Othmer, head of the department of chemical engineering at the Polytechnic Institute of Brooklyn, and Warren R. Smith, research engineer of Crown Point, N. Y.

It is claimed that 2000 sq ft of first-quality, strong, water-resistant wallboard may be obtained from one ton of sawdust. The process is said to be so simple and the equipment costs so low that every sawmill producing a few tons of sawdust per day should be able to realize profits on sawdust waste. Chips and shavings may also be converted into hard board.

In the process sawdust can be conveyed directly from the saw to the mixer where a chemical, which also comes from wood, is added. A minute or two for mixing is said to be required and not more than ten minutes for making the board by squeezing the mixture in a hydraulic press. It is claimed that not more than 15 minutes from the saw to the sawdust and to the finished board is required. Chemicals are estimated to cost less than one tenth of a cent per square foot of product. Operations can be carried out without skilled technical help or chemists.

It is claimed that the product can be nailed or otherwise attached to wood boards; it is resistant to termites, rot, moisture, warping, swelling, and shrinking; it can be molded into special shapes, complete doors, panels, or moldings. Possible applications being investigated are: Plates, cups, and saucers for camping; one-piece dories and duck boats; prefabricated walls, ceilings, floors, and roofs for factory-built houses.

## Milled Glass Fibers

IT HAS been announced that numerous uses of a new material, fiberglas milled fibers, are being developed in research laboratories. Fiberglas milled fibers are formed by hammermilling fiberglas continuous yarns into lengths ranging from $^{1}/_{32}$ in. to $1^{1}/_{2}$ in. These fibers are 0.00025 in. in diameter.

Proposed uses are the following;

An addition of 10 per cent, by weight, of $^{3}/_{4}$-in. milled fibers increases the tear strength of explosive paper used for wrapping dynamite; provides a better bond between the paper and its paraffin coating; minimizes hinging action; gives more uniform strength; and aids in disintegration of the paper after the explosion instead of leaving small pieces to smolder.

Ten per cent, by weight, of milled fibers dispersed in filtering paper gives more uniform capillarity and speeds the filtering process.

The milled fibers are said to impart improved characteristics to many high-pressure molded products.

Improvement in impact strength and longer life have been found in phonograph records in which the organic filler has been replaced with 3 per cent, by weight, of $^{1}/_{8}$-in. milled fibers, with no increase in the noise level.

Strength and performance of abrasive cutting have been improved by incorporation of $^{1}/_{4}$-in. milled fibers in the abrasive grain which is mixed with a thermosetting binder and molded into form.

Milled fibers ranging from $^{1}/_{16}$ to $^{1}/_{32}$ in. in length have been incorporated in sound-deadening paints with an improvement of 100 per cent in sound-deadening qualities.

## "Canning" Machines

FOR the preservation in storage of valuable war surplus materials running all the way from heavy machine tools to delicate instruments and electrical apparatus the Glenn L. Martin Company has developed a process of "canning" in aluminum. The development of ingenious aluminum "barriers," some of which "breathe" through a drying agent and others of which are hermetically sealed, has come about through experimental contracts with the Ordnance Department of the Army for the canning of guns. It is claimed that by such methods all sorts of manufactured articles and materials can be stored in the open for many years without rust, corrosion, or deterioration. Aluminum is used because of its resistance to corrosion, its lightness of weight, and because great surplus stocks and manufacturing potential are available.

One feature of the device is called the "balanced pressure barrier." The big can, which is now being tailored to fit field guns, contains this barrier. At night and under cloudy conditions this barrier inhales air through a screen of silica gel. In sunlight it exhales air through the gel, drying and reactivating the dessicant automatically. It is claimed that accelerated tests of the process give promise that the contents can be absolutely protected without maintenance for many years.

## Plastic Foam

A PLASTIC foam, which weighs less than a pound and a half per cubic foot and can be made to weigh as little as three quarters of a pound per cubic foot was developed by the United States Rubber Company in co-operation with Army Ordnance. The material was used to fill large steel pontoons which carried tanks over coral reefs to shore and would keep the pontoons and tanks from sinking when punctured by gunfire. Peacetime uses of the material, known as "flotofoam," are said to include insulation for homes, automobiles, trains, and airplanes, and bouyancy units for life preservers, floats, and pleasure craft.

## New Plastic

A NEW nonflammable thermoset plastic with high optical and electrical properties, good resistance to abrasion, and high resistance to oils and greases and most chemicals, has been announced by The B. F. Goodrich Chemical Company. It is known as "Kriston." It is formed by polymerizing liquid monomer in the presence of a suitable catalyst. Low temperature and no pressure are required.

Kriston monomer is a somewhat viscous, water-clear, anhydrous liquid, of specific gravity 1.25, which can be cast in simple molds. It sets to a hard heat-resistant plastic. No water or other volatile products are released during polymerization, making easy the preparation of dense nonporous articles. Shrinkage during polymerization is said to be substantially lower than that of other materials of the type.

Kriston polymer has a refractive index of 1.57, higher than that of most optical glass. The material can be made into water-clear plastic or in colors, transparent, translucent, or opaque. It has high dielectric strength and electrical resistivity.

In the cast state, Kriston is odorless, tasteless, nontoxic, and dimensionally stable.

## Proximity Fuze

A HITHERTO highly secret precision radio device used to detonate rockets, bombs, and shells automatically when the projectile comes within effective range has recently been made public. The story of the development of the VT (variable timing) fuze, as the proximity fuze is called, and a description of its operation is available in a small pamphlet recently issued by Sylvania Electric Products, Inc., one of the manufacturers of this type of fuze. Regarding the operation of the fuze the pamphlet reads as follows:

"At a distance of 7000 yards, a Japanese suicide bomber begins its run against an American cruiser. The crew of a 5″/38 gun loads a VT fuzed projectile. It handles the projectile with no special care or concern. Not only are VT fuzes as rugged as most fuzes, but they have been provided with reliable safety features in the bore of the gun. They are as safe as any fuzes used by the Navy.

"The gun crew directs the gun at the target in the usual manner and then fires the projectile. Since no time setting of VT fuzes is necessary, and since they are always 'on' in range, the fire-control problem is obviously much simpler than with time fuzes.

"At the instant the projectile is fired, a wet battery that furnishes energy to the fuze begins to be activated. The shock of fire breaks a small glass vial filled with liquid electrolyte. Centrifugal force in the rotating projectile causes this liquid electrolyte to flow toward the outside of a cylindrical cell through a stack of thin ring-shaped plates that have been carefully insulated from each other. Contact between the electrolyte and plates makes the battery electrically active. Within $^{1}/_{4}$ to $^{1}/_{2}$ second after the battery has become active, it has charged a firing condenser with electricity. Once this condenser is charged and a mercury safety switch has been opened, the projectile is 'armed' and ready to detonate when its target influences it to do so. All this has been accomplished by the time the projectile has traveled four or five hundred yards toward the Japanese bomber.

"As the projectile speeds through the air at a rate of approximately 2600 feet per second, a radio vacuum tube sends out electromagnetic waves or impulses at the speed of light—186,000 miles per second. These impulses will be reflected back to the oscillator by any target that gives a radio reflection, such as metal objects, water, or earth.

"At first the projectile is so far from the bomber that these impulses are not returned in any strength. But as the projectile approaches closer to the bomber the oscillator receives even stronger reflected impulses. These incoming impulses interact with the outgoing impulses to create a 'ripple pulse' which is amplified by vacuum tubes. If the projectile comes within a radius of about 70 ft from the bomber, this 'ripple pulse' becomes powerful enough to trigger a thyratron tube which acts as an electronic switch. This releases the electrical energy stored in the charged condenser which, in turn, operates on an electrical detonator called a squib. The blast from this squib operates a standard electrical detonating fuze, which sets off the main explosive charge in the projectile.

"The quality of the 'ripple pulse' is such that it will not set off this series of actions until the projectile reaches a point at which its area of fragmentation includes the space occupied by the bomber. Of course, this whole process of detonation required but an infinitesimal fraction of a second.

"In howitzer fire by artillery batteries on land, VT fuzed projectiles work in almost exactly the same way as in antiaircraft fire. However, instead of being detonated by electromagnetic impulses reflected from an enemy airplane, they are detonated by electromagnetic impulses reflected from the ground, at about treetop height, strewing the area with deadly fragments from which even men in foxholes could not escape.

"It was the use of the weapon against German land forces that has been credited with breaking the counterattack at the Battle of the Bulge in December, 1944."

# Pressure-Sensitive Device

A NEW instrument, the SR-4 pressure-sensitive device, has been announced by the Baldwin Locomotive Works, Southwark Division and is used to convert gas or liquid pressure to electrical energy for measuring, recording, or controlling. Extreme accuracy is claimed, and it is said to be available in several ranges up to 0 to 20,000 psi.

Since it is essentially an electronic device, results can be transmitted over long distances whether for direct reading, recording, or control. Transmission by radio is feasible. The device is based on the principle of the SR-4 strain gage. The heart of the device is a very fine filament wire bonded to a hollow metal core against which is exerted the gas or liquid pressure to be measured. As the pressure increases this filament stretches, thus changing the diameter of the wire and causing measurable changes in the electrical resistance of the wire. This change of resistance varies the amount of current flowing through the filament circuit and, when amplified, these changes show up on a dial or are used to actuate a control system. The filament is said to be sensitive to a "stretch" of the metal core of only one millionth of an inch. The device is hermetically sealed and a built-in compensator cancels out the effect of any extraneous force such as temperature. It is approximately one inch in diameter and five and one half inches long.

# Pipe Coupling

A SELF-SEALING pipe coupling which will prevent leakage or contamination of the fluid in the pipes it couples when the joint is opened is reported by the British Information Services to have been developed in England. This fitting, which can be used in any pipe line in exactly the same way as a normal pipe coupling and is suitable for systems carrying liquids or gases at pressures up to 15 atmospheres and at temperatures up to 150 C, is in effect a pipe coupling and two self-closing stop valves combined in a single device.

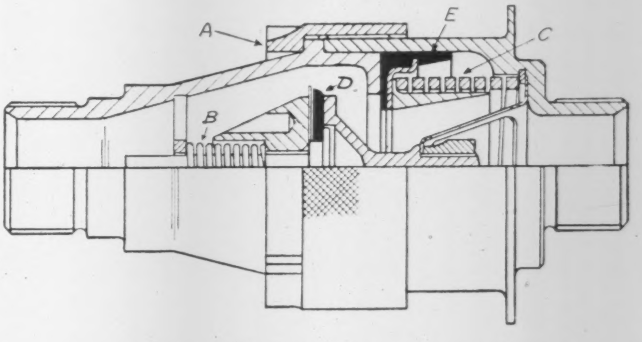


FIG. 1 SELF-SEALING PIPE COUPLING

(*A*, outer ring; *B* and *C*, compression springs; *D* and *E*, rubber valve faces.)

Referring to Fig. 1, as the outer ring *A* is unscrewed, the springs *B* and *C* extend and combine to press the halves of the coupling body apart. Thus the fluid path gradually narrows until the rubber valve faces *D* and *E* simultaneously come to rest on their seats against which they continue to be pressed by the springs. When *A* is completely disengaged each part of the coupling is free and presents a blank end at the disconnected joint. When the two parts of the coupling are brought together again and the ring *A* is screwed home, the two valves are gradually opened against the springs and the full-bore flow is once more established.

Normal ranges of sizes is from 1 cm to 30 cm equivalent bore. It is said that the coupling was extensively used by the Royal Air Force for both aircraft and fueling equipment. Bayonet fittings and other quick-release methods have been substituted for the screw-threaded ring where the pressure of the pipe-line contents at the actual time of coupling and uncoupling is moderate.

# Honors

## *Harrison*

ON October 2 the Hoover Medal Board of Award announced the election of Major General William Henry Harrison as the eighth recipient of the Hoover Medal (1945). General Harrison is vice-president in charge of operation and engineering of the American Telephone and Telegraph Company, New York, N. Y., and is a past-president of the American Institute of Electrical Engineers.

## *Durand*

At the age of 86 Dr. William F. Durand, past-president and honorary member A.S.M.E., has returned to retirement after resigning as a member of the National Advisory Committee for Aeronautics. In a letter to Dr. Durand accepting the resignation, President Truman wrote in part:

"You have had an exceptionally long and distinguished career in many fields of scientific endeavor, having been one of the original members of the NACA, appointed by President Wilson in 1915, and having served as Chairman of that Committee in World War I. After retiring in 1933 you were recalled by President Franklin D. Roosevelt to the service of your country in 1941 and reappointed a member of the NACA. As Chairman of the new Special Committee on Jet Propulsion, you organized with eminent success, the research and development program in the important new field of jet propulsion.

"With the termination of the wars with the Axis, you take with you into honored retirement, at 86 years of age, the consciousness of substantial contributions to the public interest, and particularly to the advancement of the science of aeronautics. I wish you many years of peace and happiness, in which you may enjoy the continuing fruits of your labors."

### *Wright*

On September 24 the Daniel Guggenheim Medal Board of Award announced the selection of Dr. Theodore P. Wright, Administrator of Civil Aeronautics, as recipient of the Daniel Guggenheim medal for 1945. The award citation reads: "For outstanding contributions to the development of civil and military aircraft, and for notable advancement in assuring the success of our wartime aircraft production program."

Dr. Wright was a member of the Aircraft Production Board and director of the Aircraft Resources Control Office. As an aeronautical engineer and executive he developed the airplane which won the $100,000 award in the Guggenheim Safe Aircraft Competition in 1930. He delivered the Wilbur Wright Memorial Lecture in London in May, 1945, at the invitation of the Royal Aeronautical Society, acted as technical secretary of the International Aviation Conference at Chicago, November, 1944, and participated in the U. S. Strategic Bombing Survey formed to study the results of strategic bombing of the Eighth Air Force in Europe. Prior to 1940 Dr. Wright was aeronautical engineer, plant manager, and executive of the Curtiss-Wright Corporation. As Administrator of Civil Aeronautics he has proposed a four-point program for the development of civil aviation in the United States. In the personal aircraft field this program calls for the construction of an adequate national airport system; research looking toward the development of a personal airplane for the mass market; federal assistance to flight training and aviation education; and simplification of the regulations governing flying.

### *Findley*

At a meeting of the American Society for Testing Materials held in Chicago on October 24, William N. Findley, junior member A.S.M.E., assistant professor of theoretical and applied mechanics, University of Illinois, was awarded the Charles B. Dudley medal for his paper "Creep of Plastics."

## Control of German Industry

A FIVE-POINT program for strict control of German industry, from raw materials to processing and scientific research, in order to prevent rearmament, formulated by the National Engineers Committee on the basis of studies made by 35 leading engineers and technological specialists, was made public on Sept. 26, 1945, after transmission to the appropriate U. S. authorities in Washington and abroad.

The National Engineers Committee was requested last February to make a study and to suggest measures for postwar control of German war potential. The request of the Engineers Joint Council was supplemented by the approval of the State and War Departments.

### PROHIBITION OR CONTROL OF FIVE WAR ESSENTIALS

Working within the framework of the Yalta and Potsdam agreements, the engineering group concludes that assurance that Germany will keep the peace requires institution and maintenance of effective controls of power production and distribution and industrial plant construction to: (1) Prohibit the synthetic fixation of nitrogen; (2) prohibit the production of synthetic liquid fuels; (3) prohibit the production of aluminum; (4) prohibit the development or use of atomic energy; (5) limit the capacities and production of steel and steel-products plants.

It also is proposed to eliminate danger from secret scientific research by preventing co-ordination of such effort with development facilities under German control. Economic subsidies to industry by the German government also are ruled out as a fruitful source of future war strength.

Copies of the report and recommendations have been laid before the heads of the State Department, the War Department, the Navy Department, the Commanding General of the Army Service Forces, the Foreign Economic Administration, and General Lucius D. Clay, deputy to General Eisenhower for U. S Group Control Council for Germany.

The Executive Committee of the Engineers Joint Council are The American Society of Civil Engineers, Malcolm Pirnie, past-president; American Institute of Mining and Metallurgical Engineers, Harvey S. Mudd, president; The American Society of Mechanical Engineers, Robert M. Gates, past-president; American Institute of Electrical Engineers, Charles A. Powel president; and American Institute of Chemical Engineers, Dr Lawrence W. Bass, president.

The National Engineers Committee consists of Robert E McConnell, New York, chairman; Harry S. Rogers, vice-chairman, president of Brooklyn Polytechnic Institute; Thomas F. Barton, commercial vice-president, General Electric Company; Colonel Carlton S. Proctor, consulting engineer, New York; Dr. Edward R. Weidlein, director, Mellon Institute of Industrial Research, Pittsburgh, and Dr. Clyde E. Williams director, Battelle Memorial Institute, Columbus, Ohio.

Thirty-five engineering and technological specialists in their respective fields, many of them highly placed in American industry, co-operated in the preparation of the report and recommendations.

### COMMITTEE OF SPECIALISTS IN EACH FIELD

These specialists in the fields of construction, power, the materials to be eliminated or controlled, and in research accepted the invitation of the National Engineers Committee to make a comprehensive survey as a public service. They organized into a task committee for each particular field. The recommendations of these task committees to the National Engineers Committee are regarded as the most authoritative and complete data on German industrial potential, its needs for normal civilian economy, and where the line should be drawn to prevent rearmament.

In September, 1944, the presidents of the five national engineering societies submitted to Washington and made public a general program for the industrial control of postwar Germany. The current report now outlines a definitive program for control and gives the factual and statistical basis for elimination, prohibition, or control of materials essential to armament.

The scope of the Committee's studies, according to the directive of the Engineers Joint Council to the National Engineers Committee, includes industrial control of all aggressor nations Its first report deals entirely with Germany.

### TO AVOID ECONOMIC VACUUM

The report is built around the expressed philosophy that "it is necessary to subtract from aggressor peoples, for a long period of recuperation, the fundamentals of their industrial war potential for armed aggression." At the same time it is held that "complete elimination of German industries, leaving agriculture as the sole occupation, would produce an economic dislocation and social chaos of destructive magnitude, not alone in Germany but throughout Europe."

It is pointed out that adequate enforcement of such complete elimination of industry would be practically impossible, and that such severe restrictions probably would be repudiated by world public opinion in a relatively short time, resulting in a repetition of the aftermath of World War I.

In contrast with this, framers of the engineers' report believe their recommendations would require a minimum of policing and remain effective so long as the policies of control are repeatedly adjusted, with the assistance of competent technical counsel, and adequately enforced by the policing agencies of the United Nations.

### METHODS OF CONTROL UP TO AUTHORITIES

Recommended controls, the report states, would reduce employment of the total peacetime labor force in Germany by about five per cent, a displacement which should be absorbed easily by re-employment in peacetime agriculture and consumer-goods industries.

The report details the industrial factors that must be controlled, supporting its findings with statistics and engineering data, but leaving the determination of the specific methods of control to the authorities charged with that function.

Control must be exerted, the report states, over (1) energy allocation; (2) raw-material elimination or limitation, applied to specific elements critical to war industry; (3) processing, fabricating, and new construction; (4) scientific research; (5) economic subsidies.

It is recognized that in the field of energy and among the raw materials in German economy, coal stands at the head of the list, supplying 85 per cent of the nation's energy in power and light, as well as providing the raw-material base for the huge chemical industry, the synthetic-nitrogen industry, the synthetic-fuel industry. But because coal is needed in Germany for peacetime as well as war potential industry, the report holds that instead of eliminating the coal industry, it must be controlled by the same body that controls other raw materials. Electric power, likewise, must be controlled at its source, mainly coal, the report finds.

Even if ample energy were available, modern war would be impossible without a number of products required in large quantities, the report states, namely: nitrogen for explosives, aluminum for air power, steel and steel alloys for land and sea warfare, and liquid fuels and lubricants to insure mobility of the instruments of war.

### ELECTRIC POWER

It is recommended that a comprehensive postwar control of German industry be based on a system of energy allocation. On this subject, the report states:

> The fundamental factor is energy, since it is required in one form or another to operate all processing equipment for the transformation of all raw materials into finished goods. Therefore, regulations based on energy are so inclusive that all industrial operations fall within their scope.
>
> Control of power distribution through allocation of all coal distribution, while fundamentally effective, would be cumbersome, a handicap to peaceful development quoted and would require a considerable staff. A rigid control of electric power distribution is therefore important to ensure compliance and regulation of German industry.
>
> The specific details of electric power allocation must be formulated by the Control Council in Germany possessing firsthand information of the requirements of German industrial and domestic activities. It is assumed that after productive limitations, consistent with the recommendations herein contained, have been determined for German industry, it will be relatively easy to ascertain the energy requirements to supply industrial and domestic needs. All excess capacity above that allotted to a given district, including installations in industrial plants, should be removed and all of the contiguous auxiliaries, building foundations and other services should be removed or destroyed. It should be realized, however, that the electric-power industry in Germany cannot and should not be used as the sole means of controlling other industries for disarmament purposes. Reports on the use of electric energy by individual manufacturing plants cannot be relied upon as a definite indication of the magnitude and nature of manufacturing operations.

### NITROGEN INDUSTRY

With respect to the German synthetic-nitrogen industry, the report recommends;

> 1 That all synthetic fixed nitrogen production, except cyanamide, within the borders of postwar Germany be eliminated, either by the enforced prohibition of the rebuilding of demolished plants, or the destruction or the removal of any remaining equipment.
>
> That the chemical nitrogen production in postwar Germany be limited to the by-product nitrogen of the permitted steel industry, plus not over 200,000 short tons of nitrogen as cyanamide per year. Electric power allotted to cyanamide production should be controlled accordingly.
>
> 2 That all synthetic processes and equipment suitable for hydrogenation of coal or hydrocarbon oils, and for the production of synthetic ammonia, or methanol, and in addition, any other processes for producing fixed nitrogen by low-pressure methods, be eliminated within the borders of postwar Germany, except as noted in Section I.
>
> 3 That the total amount of nitrogen allowed Germany through domestic manufacture and controlled import be restricted to the minimum amount necessary for agriculture and permitted industrial activity.
>
> That the available statistics show that the consumption of nitrogen by German agriculture for the period of 1924 to 1938 averaged 481,000 short tons per year, although the German productive capacity averaged two or three times that amount for the same period. The postwar nitrogen requirement of German agriculture should be determined at appropriate intervals by United Nations soil and fertilizer experts, on the basis of the crops grown.
>
> The needs of Germany for agricultural nitrogen in excess of the recommended domestic production can be supplied in the form of synthetic and natural nitrates from other countries.
>
> Such industrial needs as require anhydrous ammonia, which cannot be advantageously transported overseas, could be supplied from plants outside Germany on the continent.
>
> 4 That German citizens, corporations, the German government, or any instrumentality thereof, be prevented from obtaining complete or partial control or any financial interests in any nitrogen fixation plants in any country.

### SYNTHETIC FUELS

Concerning synthetic fuels, the report recommends:

> It is recommended that Germany's synthetic-fuel industry be entirely eliminated. It will be unwise to allow any part of the industry to exist, as this would tend to maintain Germany's knowledge and technique of manufacture, and would give a foundation for rapid expansion and conversion to a definite war potential.

### ALUMINUM

In order to allow Germany aluminum only for peacetime uses, the engineers would eliminate the manufacture of the metal from raw materials and allow only a light fabricating industry. The recommendations follow:

> 1 That all alumina producing and smelting plants within the borders of postwar Germany be eliminated, either by demolition or removal in accordance with the recommedation of the Reparations Commission.
>
> 2 That importation of bauxite or any alumina ores be prohibited, except for a limited amount to be used as such without smelting, as provided for hereinafter under import regulations (recommendation 8).
>
> 3 That the production of petroleum coke and carbon paste be prohibited. The electrical process for smelting aluminum requires about 0.75 lb of carbon for electrodes per pound of aluminum.
>
> 4 That the control of energy be studied by competent engineers to determine the practicability of exercising long-term regulation by the rationing of coal to generate power, either as steam or electricity, or exercising instantaneous regulations by control of electricity at central distributing stations. With the elimination of the smelting of bauxite this control would have its most direct application to the fabrication industry.
>
> 5 That the aluminum fabrication industry in postwar Germany be restricted to light industry, such as the manufacture of consumer goods. The control in this case may be exercised by limitation of size and type of manufacturing equipment.
>
> 6 That a quota for the quantity of aluminum and aluminum scrap to be imported by Germany be determined by competent authorities. It is further recommended that this quota be flexible and subject to periodic review and adjustment by the United Nations Control Council or some division thereof.
>
> 7 That aluminum and scrap now stocked in Germany be seized and distributed in accordance with the foregoing plans.

8 That the quantity of alumina used as such and aluminum compounds normally used in peacetime in such industries as the ceramic, manufacturing, and chemical be determined, and a quota based thereon, and such items be admitted up to this quota without special import license. The total amount of aluminum used in this form is small, and without smelting facilities could not be converted into metallic aluminum.

### ATOMIC POWER

With respect to potential development of atomic power in Germany, that report states:

> It is recognized that the principles of atomic energy may be known to German scientists during the period of the contemplated tenure of these regulations, but it is believed that control of such development will be readily obtained through the rigid regulation of all construction and control of power requirements, to preclude the possibility of construction of plants for the development of such atomic energy.

### STEEL AND STEEL ALLOYS

To limit the warmaking possibilities of the steel and steel-alloys industry, the report recommends:

> 1 That the productive iron and steel capacity of postwar Germany be reduced to a level sufficient only for domestic peacetime needs. Definition of this level should be the function of the United Nations Control Council and it should be subject to periodic review by the Council, with such revision as is consistent with the standard of living within Germany.
>
> 2 That the importation of iron or iron ore, and alloys or alloy ore be restricted in accordance with the foregoing quota.
>
> 3 That the importation of raw materials pertaining to the iron and steel industry, the manufacture and distribution of the finished goods, be regulated by a "Controlled Materials Plan" such as recommended for the aluminum industry.
>
> 4 That the re-equipment of the German steel industry be studied by steel experts of the Control Council for the purpose of eliminating such equipment which, because of its type or size, could be converted readily to the production of instruments of war.
>
> 5 That all duties, cartel arrangements, and state subsidies for steel, or goods and services entering into its manufacture, be prohibited.

### CONSTRUCTION CONTROLS

As to the regulation and control of future construction, the report says:

> Evasion of the regulations and controls herein recommended, intended for illegal production of war potential materials, would require large installations, as for example, facilities for the production of fixed nitrogen, synthetic oil, aluminum, steel, and atomic energy.
>
> Energy controls might be effective for the regulation of established industry, but new plants will be built, and it is therefore necessary to assure that such plants may not be convertible into war plants. Therefore the rigid control of all new construction should be maintained through the issuance of permits by a Board of Construction Control, composed of experts in all potentials of war production.

# Predoctoral Fellowships

THE National Research Council announced on September 14 that it is now ready to receive nominations and applications for the predoctoral fellowships in the natural (i.e., mathematical, physical, and biological) sciences which it is administering under a grant from the Rockefeller Foundation. These fellowships are intended to assist young men and women, whose graduate study has been prevented or interrupted by the war, to complete their work for the doctorate. It is hoped that these fellowships will do much to accelerate the recovery of the scientific vigor and competence of the country which is so seriously threatened by the loss of almost two graduate school generations of scientifically trained men and women.

This program will be administered by a Committee on Predoctoral Fellowships of the National Research Council whose members are Henry A. Barton, Charles W. Bray, Detlev W. Bronk, Luther P. Eisenhart, Ross G. Harrison (chairman, National Research Council, ex officio), W. A. Noyes, Jr., and John T. Tate, chairman: Enid Hannaford, secretary.

The annual stipend will be $1200 for single persons and $1800 for married men. In general it is expected that each recipient will spend at least eleven months per year on academic work. An additional allowance up to $500 per year will be made for tuition fees. Fellowships granted to individuals who are eligible for educational support from the "G. I. Bill of Rights" will be at such stipends as to bring the total income from these two sources to that which would be received at the above rates.

Each fellow, before entering on his graduate studies, will submit for review by the Committee on Predoctoral Fellowships a schedule, approved by the dean of his graduate school, for the completion of his work for the doctorate. This schedule, as approved by the committee, will constitute an informal agreement upon the basis of which stipend payments will be made. At the discretion of the university concerned the fellowship stipend may be supplemented by university grants. All such supplementary sources of income should be made a matter of record with the committee. The progress of the fellows will be subject to periodic review by the committee which reserves the right to cancel fellowships when in their judgment satisfactory progress is not being maintained.

Prospective candidates for these fellowships are urged to apply at once even though they may be unable to undertake their graduate study in the immediate future. Information concerning these fellowships and nomination-application blanks may be obtained by writing directly to the Secretary, Committee on Predoctoral Fellowships, National Research Council, 2101 Constitution Avenue N. W., Washington 25, D. C.

# Postwar Collegiate Research

SCIENTISTS who made the atomic bomb, radar, and a host of other vital war weapons will have a chance to return promptly to college laboratories for scientific research and teaching through $2,500,000 in grants offered to educational institutions by Research Corporation, of New York, N. Y., a nonprofit organization devoted to advancing research and technology by use of revenues from inventions assigned to it by public-spirited inventors.

### HELP FOR SMALLER COLLEGES

Preference in making these grants will be given, other factors being equal, to smaller institutions and those of more limited financial resources for research.

The five-year program announced by Dr. Joseph W. Barker, acting president, who has returned to his duties with the Corporation and with Columbia University from service as Special Assistant to the Secretary of the Navy, will result in 100 to 200 grants of $2500 to $5000 each year in order that talented young scientists, engaged for the most part in war research in uniform or as civilians, will be able to undertake at universities and colleges research of peacetime importance in pure science, especially chemistry, physics, mathematics, and engineering.

### GRANTS BEGIN SOON

The first grants will be made in a few weeks by a special committee of eminent scientists from industrial and university laboratories. The committee is composed of Acting President Barker who is also dean of engineering at Columbia University; Dr. Thomas H. Chilton, director of engineering for duPont; Dr. William D. Coolidge, X-ray consultant for General Electric Co.; Timothy E. Shea, manufacturing engineer of Western Electric Co.; Dr. Lloyd P. Smith, associate research director of Radio Corporation of America; Col. Stafford L. Warren, professor of medicine at the University of Rochester; and Dr

Robert R. Williams, inventor of the synthesis of vitamin $B_1$ and co-ordinator of research of Research Corporation.

Grants will be made to the institutions at which the scientists will work and teach. The funds allotted will be available for the purchase of needed equipment and for employment of assistants either as fellows or otherwise. Awards will be based primarily on the demonstrated ability of the men who will conduct the researches and contribute to the teaching program of the school.

### SCIENTISTS FOR NEXT GENERATION

"For the past four or five years," said Dr. Barker, "the Government, through the Office of Scientific Research and Development, the National Defense Research Council, the Army, the Navy, and the Air Force, has supported a vast research and development program into which has been drawn the great majority of the most competent university research men. Already the demobilization of these research projects is under way. When their war jobs are finished many of these talented young scientists should be going back to college laboratories and lecture rooms to train and inspire the next generation of science.

"War conditions have greatly disturbed our educational institutions by diversion of talented members of their faculties into war research, by drawing off faculty and students into military service, by utilizing educational facilities for military service training programs and by interrupting sources of financial support.

"Research budgets have been drastically curtailed, especially in the smaller institutions, which in many cases have not had opportunity to undertake Government research on a substantial scale. The financial strength of many institutions also has been impaired by the depression and the war conditions which followed. Now new burdens are thrust upon them as young men from the services return to resume their interrupted training.

### RETURN TO PEACETIME FOOTING

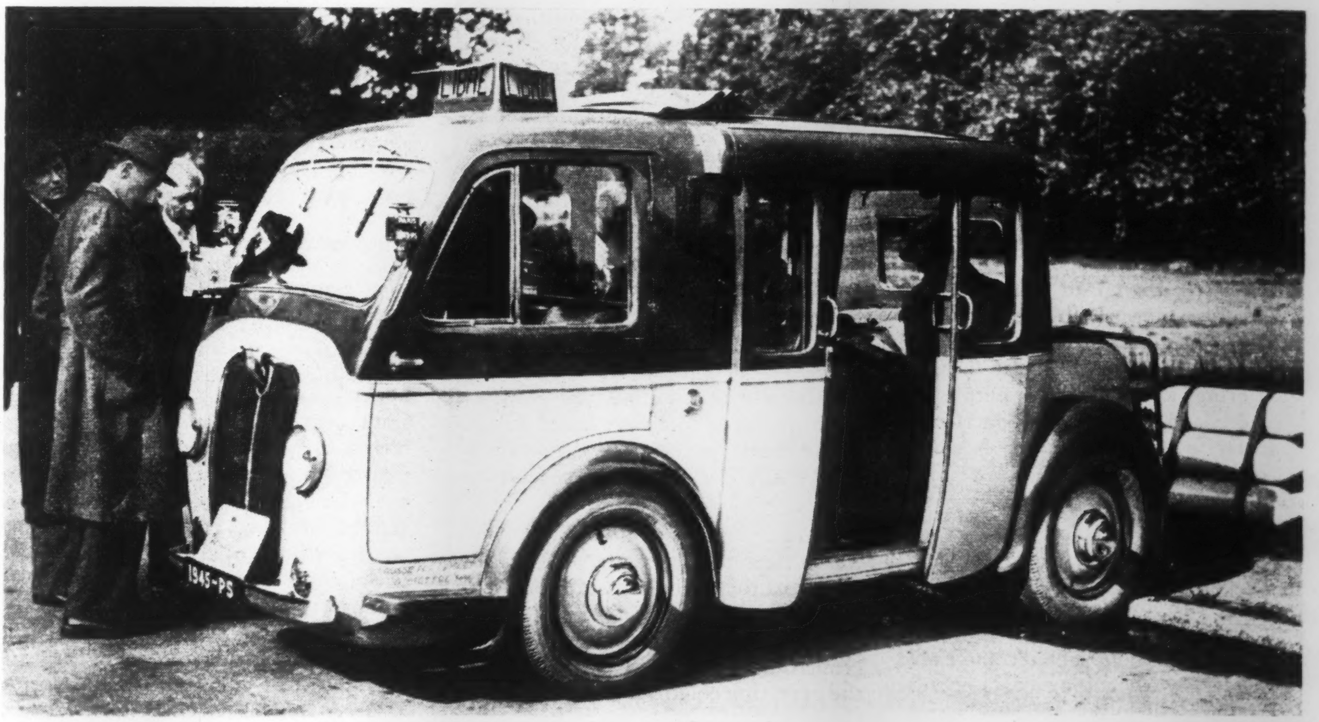
"Research Corporation's program of special postwar grants will round out the plans that are being made for the most effective and most prompt return of the war-engaged scientists to peacetime fundamental and applied research," Dr. Barker explained. "The Rockefeller Foundation has already announced a comprehensive plan of pre-doctoral fellowships which will return to college former graduate students who left their studies and researches for war research. Current government legislation and proposed bills being considered by Congress will aid the return to college of students whose scientific and technological education was interrupted by the war. Research Corporation grants will assist colleges in building research-minded staffs which will help train the students returning to colleges from the war, as well as the future contingents of students from our secondary schools in future years."

The grants are made possible by the fact that during the war years research programs that would be normally supported by Research Corporation grants have been laid aside in order to free men and facilities for war research.

### GRANTS MADE FROM PATENT REVENUES

Research Corporation was begun in 1912 with the gift through Dr. F. G. Cottrell, of patent rights on electrical precipitation, which is used for removing dust, fume, and mists from industrial gases and from the atmosphere. From revenues derived from these and other patents it has made grants of $1,279,637 in past years to 52 institutions. In recent years Research Corporation has served universities by administering inventions that may arise in their laboratories.

To scientists of the Office of Scientific Research and Development, Army, Navy and other war research agencies, the possibilities of these grants are being made known with an invitation to send applications to Dr. Robert R. Williams, Research Corporation, 405 Lexington Avenue, New York 17, N. Y.



*French Press and Information Service*

THE PARISIAN TAXI OF THE FUTURE

(This taxi has been chosen as the "taxi of tomorrow" by judges at the automobile exposition at the Bois de Boulogne. It has an all-steel Renault chassis, designed to carry comfortably 5 or 6 passengers, and can navigate in tight areas much like the "jeep." Special features are a prominent sign on the roof, indicating that the driver is free, and rolling doors that slide gently together, eliminating the hazard of nipped fingers.)

# COMMENTS ON PAPERS

*Including Letters From Readers on Miscellaneous Subiects*

## Utilizing Small Sizes of Anthracite

### Comment by W. T. Brown[1]

Referring to the section of the paper[2] on "The burning of mixtures of small anthracite and bituminous slack on stokers," this outlet for small anthracite would seem to offer the greatest possibilities for moving large quantities.

At the Steelton, Pa., plant of the Bethlehem Steel Company, fine anthracite and coke breeze are being used successfully on stoker-fired boilers. Layers of small anthracite and coke breeze are laid on the stoker and fed into the boilers. There are many boiler plants throughout the United States burning coke breeze or bituminous slack coal which could successfully use small anthracite.

The "packaged fuel" made from anthracite fines, with 10 per cent bituminous coal fines and 6 to 7 per cent asphalt, makes an excellent domestic fuel. There are many briqueting plants throughout the United States, which are only briqueting bituminous coal fines, but which could use a large quantity of small anthracite.

The use of small anthracite with coking coal for production of coke has some serious objections when the coking rate is faster than 1 in. per hr in by-product coke ovens.

The use of 5 per cent very fine (minus 20-mesh) anthracite mixed with coking coals on slow coking time improves the blockiness of the coke, but when carbonized faster than 1 in. per hr, small cross-fractures develop in the coke, as a result of shrinkage. These cause the coke to break up in the blast furnace, which brings about excessive burning of the tuyères and loss of iron production.

Anthracite is an inert carbon which does not coke and each minute piece of anthracite in the coke causes a small cross-fracture.

Anthracite fines have a high ash content, which increases the ash content of the coke, thereby decreasing iron production.

Anthracite fines are not recommended for blending with coking coal, because the mixture will lower iron production.

The writer does not recommend the use of small anthracite for blending with coking coals when carbonized faster than 1 in. per hr, because high-ash coke and excessive burning of the blast-furnace tuyères will reduce iron production.

It is recommended that the surplus small anthracite be used with bituminous slack or coke breeze on stokers in boiler plants throughout the United States; that the surplus small anthracite be briqueted with bituminous-coal fines and asphalt at all briqueting plants in the United States; and that the price of small anthracite be reduced, so that it may be used economically.

### Comment by J. D. Clendenin[3]

In a series of tests conducted in cooperation with the Stoker Research Laboratory staff at The Pennsylvania State College, different mixtures of two anthracites and two bituminous coals were burned on a Skelly-type single-retort underfeed stoker installed in the test furnace at the laboratory. The nominal capacity of the stoker is 540 lb per hr, but at a definite feed rate the actual capacity depended upon the particular mixture of anthracite and bituminous coal.

The character of the coals tested may be described as follows:

| | |
|---|---|
| Pittsburgh seam (HV) | 2 In. × 0, nut and slack |
| Lower Kittanning seam (LV) | 2 In. × 0, mostly slack (much fines) |
| No. 4 buckwheat[a] | Hard-burning, medium-volatile (6.4 per cent, dry basis) |
| No. 5 buckwheat[a] | Free-burning, high-volatile (9.2 per cent, dry basis) |

[a] Western Middle Field.

Various combinations of anthracite and bituminous coal were tested, ranging from 20 to 50 per cent of the former, and as a result the following general conclusions were deduced:

1 The mixing of the junior buckwheat sizes of anthracite with bituminous coal for use on industrial underfeed stokers may or may not result in improved operation, depending upon the properties of the coals mixed and upon the operating conditions; i.e., consideration must be given both to the anthracite-bituminous coal combination and to the stoker-furnace combination.

2 Markedly different performance was obtained when two different anthracites were used with the same bituminous coal. Likewise, when two different bituminous coals were used with the same anthracite.

3 Although only two anthracites were tested, the results suggest that the burning characteristics as well as the size of the anthracite used with a given bituminous coal should be considered. For bituminous coals containing excessive percentages of fines, the addition of a No. 5 buckwheat free-burning anthracite may produce some slight improvement. It is believed, however, that the use of a free-burning anthracite of No. 4 or No. 3 buckwheat size might have been definitely advantageous because the larger sizes would tend to counteract the undesirable effects of the fines on the distribution and flow of air in the fuel bed.

4 The use of a No. 5 buckwheat anthracite with a bituminous slack containing a large proportion of fines cannot be recommended because it aggravates rather than mitigates an already bad fly-ash condition.

5 The percentage of anthracite required to give optimum conditions will vary with the bituminous coal used and probably also with the furnace. For the two bituminous coals tested, the optimum appeared to be 25 per cent of No. 5 buckwheat with the Pittsburgh seam coal, and 35 per cent of No. 5 buckwheat with the lower Kittanning seam coal. Over the entire range of blends investigated, the use of the particular No. 4 anthracite tested was detrimental to the fuel-bed conditions and to general efficiency with both bituminous coals. When used with the lower Kittanning seam coal it was virtually impossible to maintain ignition of the fuel bed, except by very frequent poking. The least objectionable combination of No. 4 buckwheat anthracite seemed to be a 35 per cent blend with the Pittsburgh seam coal.

6 As a consequence of the relatively high moisture content of the No. 4 and No. 5 buckwheat anthracites, there was some difficulty with the coal feed be-

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[1] Pittsburgh, Pa.

[2] "War Problem of Increasing Utilization of Small Anthracite," by J. F. Barkley and William Seymour, Mechanical Engineering, vol. 67, 1945, pp. 457–462.

[3] School of Mineral Industries, The Pennsylvania State College, State College, Pa.

TABLE 1 TYPICAL SCREEN AND ASH ANALYSIS OF A WHOLE SILT, 1943

| Screen size | Each fraction, per cent | Ash content,[a] per cent | Cumulative screen fraction, per cent | Cumulative[b] ash content, per cent |
|---|---|---|---|---|
| Plus 10-mesh | 0.7 | 9.8 | 0.7 | 9.8 |
| 10 × 20 | 4.7 | 12.9 | 5.4 | 12.5 |
| 20 × 30 | 5.6 | 16.7 | 11.0 | 14.6 |
| 30 × 40 | 11.9 | 21.7 | 22.9 | 18.3 |
| 40 × 60 | 22.9 | 23.2 | 45.8 | 20.8 |
| 60 × 80 | 10.1 | 25.2 | 55.9 | 21.6 |
| 80 × 100 | 6.8 | 26.6 | 62.7 | 22.2 |
| 100 × 200 | 18.8 | 28.5 | 81.5 | 23.7 |
| 200 × 325 | 17.4 | 40.6 | 98.9 | 26.6 |
| Minus 325-mesh | 1.1 | 43.2 | 100.0 | 26.8 |

[a] By analysis (dry basis).

[b] Calculated from screen and ash analyses.

cause the anthracite-bituminous coal mixtures would "funnel" in the hopper and/or "arch over" the feed screw.

Referring to the section on method of producing and burning "packaged fuel" made from anthracite fines:

At the Mineral Industries Experiment Station, a series of laboratory tests have been conducted on the agglutination of anthracite silt with bituminous coals. A summary of the results of this unpublished work may be of interest to the briqueting and fuel-packaging industries. In these tests the A.S.T.M. Proposed Method for Measuring the Agglutinating Strength of Coals was followed. A series of Pennsylvania bituminous coals were tested in order to find a coal that possessed a high agglutinating-strength-test value. A lower Kittanning seam coal of about 18 per cent volatile-matter content (moisture, ash-free basis) from Somerset County gave a value of 13.5 kg at the 1 to 15 ratio.

In order to observe the agglutinating strength of this lower Kittanning coal with anthracite, another series of tests was conducted in which various "on-mesh" sizes of air-dry (about 1 per cent moisture) anthracite silt, ranging from "on 30-mesh" to "on 200-mesh,"[4] were substituted for silicon carbide in the proposed test. The following ratios of bituminous coal to silt were used: 1 to 9, 1 to 12.5, and 1 to 15. The agglutinating strength of the latter ratio, for all of the "on-mesh" sizes tested, did not exceed 2.5 kg in any instance. The agglutinating strengths for all three ratios with the "on 50-mesh" and "on 60-mesh" anthracite silt were anomalous, in some cases being higher and in other cases lower than was expected from the strength observed for the other "on-mesh" sizes; at this writing the anomaly has not been explored further. The maximum strength of about 10.5 kg was attained at the 1 to 9 ratio, using "on 30-mesh" (everything through 30-mesh screened out) silt; with "on 100-mesh" silt a strength of approximately 6.5 kg was observed, while with "on 200-mesh" silt, the value had decreased to 1.5 kg. When the whole silt (Table 1) was used at the 1 to 9 ratio, the strength was nil.

The effect of moisture in the silt on the agglutinating strength of the lower Kittanning coal with "on 100-mesh" silt is pertinent. In this series of tests no glycerine was used as called for in the proposed method. Instead, enough water was added to the air-dry anthracite to bring the total moisture content up to 5, 10, 15, 20, and 25 per cent. Curiously enough, at 10 per cent moisture on the silt and at the 1 to 9 ratio of binding coal to air-dry "on 100-mesh" silt, the agglutinating strength increased sharply to about 10 kg from about 3 kg for the air-dry and 5 per cent moisture content silt. Finally, compare this 10-kg value with the value of about 6.5 kg for the same-size silt in the tests described previously in which 1 drop of glycerine was used to wet the mixture.

The section of the paper, "use of anthracite fines in the production of coke," is commented on as follows:

Anthracite for blending in by-product coke manufacture has been supplied and is now being supplied from all four fields of the anthracite region. At least three different collieries in the western middle field have supplied anthracite; three in the eastern middle field; one in the southern field; and one in the northern field; no doubt there are others. No information is at hand stating the relative suitability of each of these anthracites. On the basis of specific gravity-volatile matter content characteristics alone, it is to be expected that anthracites from any of the fields would be suitable. On the other hand, it appears doubtful whether specific-gravity and volatile-matter-content characteristics alone are sufficient grounds for evaluating an anthracite, because the size of the anthracite is manifestly very important, and in addition, strength and stability characteristics and possibly particle shape of the anthracite seem to possess significance.

In our laboratory, we have made some preliminary small-scale carbonization tests to compare the relative value of finely pulverized anthracite with No. 5 buckwheat size for blending in coke manufacture. Ten per cent of anthracite (No. 5 buckwheat) pulverized to minus 70 mesh was blended with a Pittsburgh seam coal and coked in a small two-wall heated oven holding a 7 to 8-lb charge of coal. The resultant cokes showed virtually no improvement in blockiness over the cokes from the straight Pittsburgh coal, while the cokes from a blend containing 10 per cent of No. 5 buckwheat showed a marked increase in the blockiness and size of the coke. Using the microstrength index as a measure of the relative inherent strength of the cokes, the coke made from the blend containing the pulverized anthracite appeared to be considerably weaker than either of the other two cokes which seemed to possess approximately equivalent inherent strengths. These results are in accord with the results[5] of similar work by Roberts in which box-coking tests were made using 6 per cent of anthracite (No. 5 buckwheat) pulverized to minus 100-mesh size and 6 per cent of No. 5 buckwheat-size anthracite.

### Comment by Fred Denig[6]

It appears to the writer that the most promising and important utilization of anthracite fines is in the manufacture of packaged fuel or briquets. Such a fuel, though high in ash, should provide a wartime substitute for other house-heating fuels, now so limited in quantity due to demand by various war industries.

The field for utilization of anthracite fines in the production of coke is, in the writer's opinion, very limited. It has been known for many years that anthracite fines, when blended in a small percentage with suitable bituminous coking coals, tend to increase the size and "blockiness" of coke, and fines have been used by a few plants for production of foundry coke. Many other plants have used the finer sizes of coke breeze in making foundry coke, having found this procedure most satisfactory. The use of fine coke breeze has one distinct advantage over anthracite fines in that the breeze is available at the plant, whereas anthracite fines must be shipped in from outside.

Our own coke plants have considered the use of anthracite fines at various times, some full-scale oven tests having been made almost 25 years ago. Very recently we made complete tests of various blends of coal containing 5 per cent of anthracite fines and compared the results with a standard blend of 80 per cent high-volatile and 20 per cent low-volatile coals.

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[4] The size consists were not disturbed except by removal of the "through 30-mesh" or the "through 200-mesh" material, or whatever the particular "on-mesh" size required.

[5] See Circular No. 16 (1944), Mineral Industries Experiment Station, The Pennsylvania State College.

[6] Vice-President, in Charge of Research, Koppers Company, Pittsburgh, Pa. Mem. A.S.M.E.

In evaluating any new blends of coal, we always take into consideration coke quality, both physical and chemical, yield of salable coke, and the yields of gas and other by-products. Usually we expect some of these evaluation factors to be favorable and others unfavorable as compared to standard coal blends in use. In the case of the anthracite blends, most of the evaluation factors were unfavorable, one or two were equal, and none was favorable as compared to coal blends not containing anthracite.

The so-called "physical fuel value" is a measure of physical quality of coke. This was considerably lower for the anthracite-containing cokes than for the standard blend. This decrease in physical fuel value was largely caused by the tendency of the anthracite-containing cokes to crumble into breeze and dust, as shown by the tumbler test. In addition to inferior physical quality, the cokes containing anthracite were also higher in ash content.

Although total coke yields were about the same from the cokes containing anthracite as from the standard blend, the yields of salable coke were less due to increased breeze production. When the coke was crushed for production of smalle sizes, the comparative loss of salable coke became even more pronounced.

Send-out gas production was approximately 4 per cent less from the anthracite blends than from the standard blend. Tar and light-oil production were about the same.

Since coke quality and yield are decreased by use of anthracite, there is no justification for its use from the standpoint of these factors. When there is added to these unfavorable results a decrease of as much as 4 per cent in the surplus or send-out gas, the picture becomes wholly unpromising, especially for those plants supplying coke-oven gas to cities.

It seems to the writer that the greatest contribution that the by-product coke ovens can make to our war effort is to continue to make the maximum amount of high-quality coke, together with the maximum yield of gas, light oil, and other by-products so important in our war-production program. From the standpoint of our own plants, the use of anthracite fines in the coal blend would be a step backward from these objectives.

### COMMENT BY W. T. DEVENEY[7]

We have been using anthracite fines in the production of foundry coke for more than a year.

After observing the experience of the Laclede Gas Company in St. Louis, with the use of anthracite, we ran a number of experiments with coals used at our plant. As a result, the coal mix for the production of foundry coke was changed from 50 per cent medium volatile and 50 per cent low volatile to 52 per cent medium volatile, 42 per cent low volatile, and 6 per cent anthracite. The medium-volatile coal is a West Virginia Eagle seam and the low-volatile coal a mixture of Pocahontas No. 3 seam and Beckley seam from the same state. The anthracite used is No. 5 buckwheat mined near Mahonoy City, Pa., and is essentially between 10 and 100 mesh in size. The volatile matter averages 5 per cent with an ash content of about 15 per cent. It is a true anthracite.

The use of anthracite fines resulted in a decreased coking time with about a 20 per cent increase in foundry-coke production, without loss of any desirable physical properties. No difficulty has been reported by the foundries using the coke made from the new mix.

Having anthracite on the plant, the running of experiments was comparatively simple, and numerous test runs, producing domestic coke, have been made. It appears that a product of similar characteristics can be made with anthracite in the mix as without it, provided the blocking effect of the anthracite is compensated for by varying the high- and low-volatile coal proportions in the mix.

One item in connection with anthracite should be stressed. The very high moisture and ash contents, when compared with those of usual coking coals, demand a considerably lower cost on a comparative basis.

### COMMENT BY J. H. KERRICK[8]

The following gives briefly the operational results of mixtures of anthracite and bituminous on multiple-retort underfeed stokers in large industrial applications.

A series of tests, covering a period of several months, were conducted in 1936, to ascertain the proper blend of No. 4 buckwheat anthracite and bituminous coal to meet a particularly variable load demand at the subject plant. Mixtures of from 0 to 35 per cent anthracite in blend were developed using a central Pennsylvania bituminous coal. Efficiency tests were run; capacity tests were conducted; and the selected percentage of anthracite was mixed with several classifications of bituminous coal to determine the effect using bituminous with various ranges in volatile.

With reference to the central Pennsylvania bituminous which appeared to develop the best results in this particular application, the company engineers report:

"The improvement in firing conditions achieved through the addition of anthracite was marked. In fact the mixed fuel acted like an entirely different coal from the usual bituminous coal. The particular bituminous is characterized by its poor coking properties which result in blowover, heavy smoke, bad clinkers, and low efficiency. The anthracite seemed to temper the bituminous coal. The resulting fuel coked up extremely well, did not blow over, did not smoke excessively, and showed a material reduction in clinker trouble."

The straight bituminous developed a boiler efficiency of 76.6 per cent. With an intermixture of $77\frac{1}{2}$ per cent bituminous and $22\frac{1}{2}$ per cent No. 4 buckwheat anthracite, the boiler efficiency was increased to 80.3 per cent. This resulted in a dollar-wise operating gain to the company of approximately $100,000 for the first 50,000 tons of anthracite purchased.

As is always the case in the selection of a bituminous coal for a particular application, the selection of a mixture is dependent upon the physical plant and the load characteristics. Having determined the proper percentage of each fuel to be blended for a particular application, it is extremely important that intimate mixtures be developed and maintained.

Following the work done at this plant, a number of installations were developed which varied only slightly in the percentage of anthracite used; these variations being governed particularly by the type of installation with reference to furnace design, load characteristic, and bituminous fuel used. It has always been recognized that the addition of 20 to 30 per cent anthracite could not materially change the combustion principle evolved around the multiple-retort and single-retort underfeed stoker. In other words, it is not to be expected that the "tail can wag the dog." However, it has been definitely established through actual practical application that the addition of anthracite barley or No. 4 buckwheat, in proper proportions and intimately mixed, does favorably affect the resultant composite fuel to the extent that the following results have been generally obtained:

1 Lower cost per million Btu or 1000 lb steam generated

2 Reduced clinker problem

3 Material reduction in smoke

4 Better air control through fuel bed

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[7] The Peoples Gas Light and Coke Company, Chicago, Ill.

[8] Fuel Engineer, The Philadelphia and Reading Coal and Iron Company, Philadelphia, Pa. Mem. A.S.M.E.

5 Less char

6 Reduced iron loss

7 Material reduction in loss in storage from spontaneous combustion.

In conclusion, it must be stated that much of the lack of interest in blends has been due to lack of information on accomplishment and the problem of proper intermixture. Much of the work on the study and application of mixtures was done long before the war emergency became a factor. In those prewar days, the answer was purely one of economics. The present situation, as generally discussed in this paper, has the dual advantage of relieving large stores of small-size anthracite accumulated through increased war demands for other sizes of anthracite, and of effecting economies in boiler-plant operation.

### Comment by Edmund McCarthy[9]

A number of factors, including design of combustion equipment, available coal supply, and load conditions, determine whether a blend of bituminous and small-sized anthracite can improve the performance over straight bituminous coal at a stoker-fired plant.

In the case of heavily loaded power boilers, it is necessary to have accurate information on the size, quality, and burning characteristics of both the bituminous and the anthracite coal before it can be determined whether a blend is likely to prove satisfactory.

Where low-volatile slow-burning bituminous coal having good coking characteristics is encountered, an admixture of small-size anthracite will usually result in lower efficiency and loss of capacity. The same will hold true for any bituminous coal which has a tendency to produce a sluggish fire as a result of high moisture content. On the other hand, where comparatively dry fast-burning bituminous is available for stoker-firing, it is worth while to consider an admixture of from one-sixth to one-fifth anthracite by volume.

At a plant having a number of 600-hp longitudinal-drum B.&W. units, a mixture of 80 per cent central Pennsylvania "B" seam crushed run-of-mine bituminous and 20 per cent No. 4 buckwheat-size anthracite from the western middle field was used to good advantage on seven retort Taylor underfeeders with projected grate areas of 104 sq ft. The bituminous coal in the mixture had a high heat value, and it was extremely dry and friable. Although it contained a high percentage of slack, its coking properties when burned straight were very poor. The admixture of high-moisture small-size anthracite had the effect of increasing the weight per unit volume, and this in turn produced a better fuel-bed structure and improved the coking action. The mixture behaved extremely well under all conditions of operation including peak loads of short duration at approximately 230 per cent of rated output. On the same units, the blending of anthracite with other high-grade low-volatile bituminous coals having good coking characteristics did not prove to be economical.

The mixture mentioned was subsequently tried out on a 2500-hp special Ladd-type boiler, equipped with a Taylor stoker having about 700 sq ft of projected grate surface, where daily peak loads exceeding 500 per cent of rated output normally prevailed. At high ratings, weak spots developed in the fuel bed and excessive blowover took place. Thereupon, the mixture was tried out with a similar "B" seam coal which was sold as a modified run-of-mine product with $^3/_4$-in. slack removed. Although considerable breakdown took place in passing through the crusher at the unloading towers, the size consist was greatly improved and fairly satisfactory performance was obtainable with the admixture.

In order to operate successfully with a blend of bituminous and small-sized anthracite, it is necessary to formulate a method of mixing which can be carried on without a great deal of supervision at each particular plant; and quite frequently a certain amount of ingenuity is required to avoid pronounced segregation of anthracite and bituminous in overhead bunkers.

During the summer of 1937, the writer devised and put into effect a process of blending bituminous with small-sized anthracite in cargoes loaded at coal ports in New York Harbor. Since the process could be adapted to cargo mixtures of any size, it was immediately accepted as standard practice; and from hundreds of cargoes loaded in this manner, not a single complaint was ever received on poor mixtures at stoker hoppers.

In blending bituminous coal with No. 5 buckwheat-size anthracite an intimate mixture of the two coals should take place in order to insure uniform moisture distribution. As the size of anthracite increases, the two coals appear to intermix more readily; and the process of blending can be simplified to some extent wherever it is possible to use No. 3 buckwheat (barley) instead of No. 4 or No. 5.

Where an admixture is to be used for the purpose of improving the fuel-bed conditions of power and industrial units, it is advisable to select anthracite whose general characteristics lie closest to the characteristics of the bituminous with which it is to be blended. Flexibility in operation and high burning rates are more readily obtainable when the anthracite in a mixture is of comparatively low specific gravity with ash content around 10 per cent.

### Comment by D. L. Newkirk[10]

During the fall of 1943, our attention was directed to the practice of Laclede Gas Light Company at St. Louis where anthracite additions to their coke-oven coal mixtures had resulted in improvement of foundry coke.

As our coal supplies were becoming difficult, we obtained several cars of No. 5 buckwheat fines from Hazleton, Pa. This anthracite is a special product of the hard low-volatile section of the Lehigh Valley anthracite region. Our sample was prepared by the Hydrotated Anthracite Fuel Company, Hazleton, Pa. It is claimed by the suppliers that only coal having a dense structure, true specific gravity of about 1.7, and a very low volatile is suitable. It must be washed and screened. Our sample had the characteristics given in Table 2.

TABLE 2 CHARACTERISTICS OF ANTHRACITE SAMPLE

| | | Screen analysis | | |
|---|---|---|---|---|
| Volatile matter, per cent | 4.0 | | On 10 mesh | 4.6 |
| Sulphur, per cent | 0.66 | Through 10 | On 20 mesh | 48.6 |
| Ash, per cent | 13.9 | Through 20 | On 40 mesh | 36.3 |
| Fusion, deg F | 2800 | Through 40 | On 100 mesh | 9.0 |
| True specific gravity | 1.64 | Through 100 | | 1.5 |

Two tests were made using this material in mixtures with our regular stock. The results are shown in Table 3 and in the accompanying graphs. Some average results with our regular mixture of 75 per cent Pond Creek and 25 per cent low-volatile are given for comparison.

An increase in percentage of the large sizes of coke was obtained. This is shown in the curves, Fig. 1, where the screen analysis of the "run-of-oven coke" is plotted as the solid-line curves. The accumulated percentages on $3^1/_2$-in. and 3-in. screens are given in Table 3. It will be noticed that the increase of large sizes from the 75-20-5 mixture was considerable; 55.6 per cent being re-

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[9] Fuel Engineer, Fairmont Coal Bureau, New York, N. Y. Mem. A.S.M.E.

[10] Superintendent of Blast Furnaces and Coke Ovens, Ford Motor Company, Dearborn, Mich.

TABLE 3 RESULTS OF TESTS ON FUEL MIXTURES

| Date | Average for Sept., 1943 | October 5, 1943 | October 7, 1943 |
|---|---|---|---|
| Coal mixture | | | |
| Pond Creek, per cent | 75 | 75 | 80 |
| Low volatile, per cent | 25 | 20 | 15 |
| Spec. anthracite, per cent | | 5 | 5 |
| Analysis of coal mixture: | | | |
| Moisture, per cent | 4.1 | 4.6 | 4.6 |
| Volatile, per cent | 29.4 | 28.1 | 28.4 |
| Sulphur, per cent | 0.63 | 0.57 | 0.61 |
| Ash, per cent | 7.2 | 7.5 | 7.7 |
| Coking time 16 hr 48 min in each case | | | |
| Run-of-oven coke: | | | |
| Per cent on $3^1/_2$-in. screen | 28.0 | 55.6 | 45.1 |
| Per cent on 3-in. screen | 49.0 | 72.2 | 60.8 |
| Foundry coke: | | | |
| Per cent on $3^1/_2$-in. screen | 28.2 | 62.7 | 46.8 |
| Per cent on 3-in. screen | 53.2 | 87.8 | 69.0 |
| Analysis: | | | |
| Volatile, per cent | 0.3 | 0.4 | 0.3 |
| Sulphur, per cent | 0.52 | 0.48 | 0.49 |
| Ash, per cent | 8.9 | 9.0 | 8.8 |
| Approximate specific gravity | 0.936 | 1.01 | 0.977 |
| True specific gravity | 1.91 | 1.83 | 1.87 |
| Per cent of cell space | 51.1 | 45.25 | 47.80 |
| Shatter test | 74.2 | 89.0 | 84.0 |

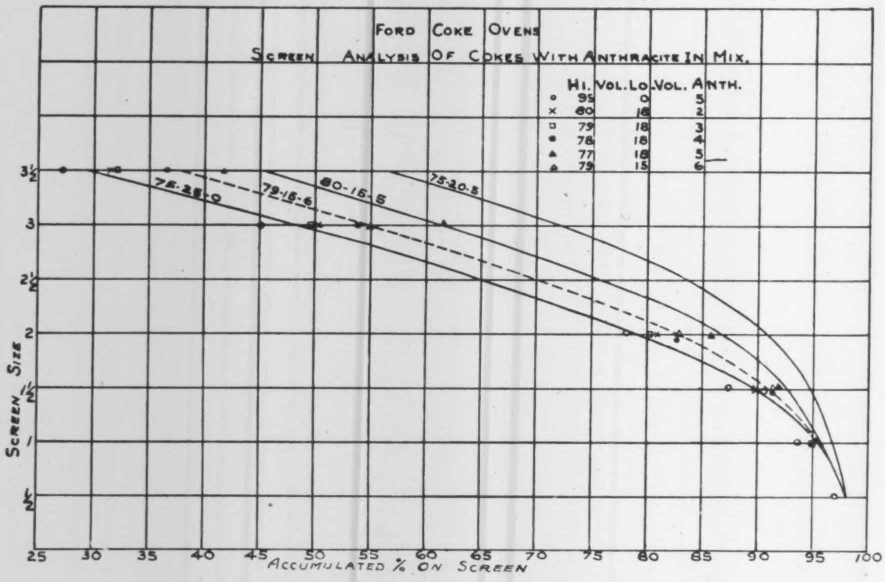

FIG. 1 SCREEN ANALYSIS OF COKES WITH ANTHRACITE IN MIX

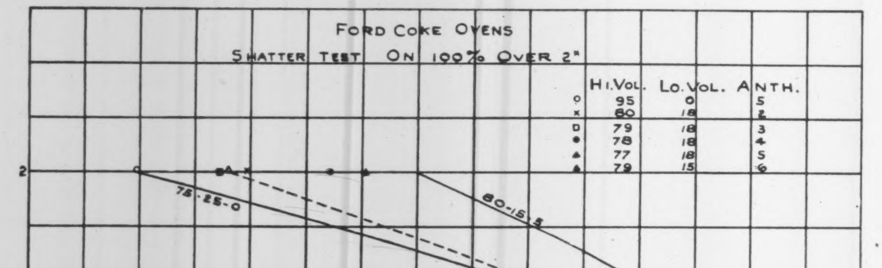

FIG. 2 SHATTER TEST ON 100 PER CENT OVER 2 IN.

tained on the $3^1/_2$-in. screen, compared to 28 per cent from the standard mixture of 75 per cent Pond Creek and 25 per cent low volatile. The 80-15-5 gave less of the large sizes than 75-20-5 but more than the standard mixture.

The shatter test was made on 50-lb samples of over 2-in. sizes of the foundry coke. A screen analysis was made after this material had been dropped 6 ft four times in usual test equipment. The results are given in Fig. 2. The amount retained on the 2-in. screen is reported as "shatter test" in Table 3. The increased strength for the 80-15-5 is shown by 84.0 per cent retained on the 2-in. screen after dropping compared to 74.2 per cent for coke from the standard mixture. Coke from the 75-20-5 mixture was slightly stronger than coke from the 80-15-5 mixture.

Both these mixtures produced coke too large for our blast furnaces, so more anthracite was obtained and mixtures given in Table 4 were tested. The results are also given in Figs. 1 and 2, as isolated points which are identified by symbol given in a code on the graph. The size of the coke from the 80-18-2 and from the 79-18-3 mixtures was slightly larger than from the standard mixture. From the 78-18-4 mixture, the coke was definitely larger and from the 77-18-5 it was still larger, being about the same as from the 80-15-5. The shatter tests showed an increase in strength as the percentage of anthracite increased.

Coke from both the 80-15-5 and the 77-18-5 mixtures being larger than desired, we made a few tests using these mixtures with reduced coking time of 16 hr and 16 min. After using the 80-15-5 for a period of several days, a mixture 79-15-6 was tried and has been used since. The reduced coking time reduced the percentage of large sizes and the strength, although not to quite as low as for the standard mixture at the longer time. The results are given in Table 5 and for the 79-15-6 mixture as the dotted-line curve in Figs. 1 and 2.

The mixture 79-15-6 has produced sufficient coke over 4 in. for the foundry and the required tonnage of $1^1/_2$- to 3-in. coke for the blast furnaces, the remaining egg, nut, and pea being sold as domestic. The only mitigating factor was an increase of approximately 1 per cent in breeze production. The coke produced from the anthracite blend is stronger, harder, more blocky, and more brittle. It is the increase in brittleness which increases the "abradability" and therefore the breeze percentage.

The blast-furnace performance involving combustibility, direct reduction, and solution loss was slightly improved as shown by Table 6.

The by-products and gas yields at the

TABLE 4 RESULTS OF TESTS ON MIXTURES CONTAINING ADDITIONAL ANTHRACITE

| | | | | | | Standard mix |
|---|---|---|---|---|---|---|
| Coal mixture: | | | | | | |
| Pond Creek, per cent | 95 | 80 | 79 | 78 | 77 | 75 |
| Low-volatile, per cent | 0 | 18 | 18 | 18 | 18 | 25 |
| Anthracite, per cent | 5 | 2 | 3 | 4 | 5 | 0 |
| Coking time 16 hr and 48 min in each case | | | | | | |
| Run-of-oven coke: | | | | | | |
| Per cent on $3^1/_2$-in. screen | 27.1 | 31.5 | 31.9 | 36.6 | 41.9 | 28.0 |
| Per cent on 3-in. screen | 45.1 | 49.9 | 49.4 | 54.0 | 61.3 | 49.0 |
| Foundry coke: | | | | | | |
| Per cent on $3^1/_2$-in. screen | 31.4 | 32.0 | 31.5 | 39.4 | 54.5 | 28.2 |
| Per cent on 3-in. screen | 68.4 | 56.0 | 56.2 | 58.2 | 73.8 | 53.2 |
| Shatter test | 73.9 | 77.9 | 76.9 | 80.9 | 82.1 | 74.2 |
| Per cent cell space | 45.8 | 50.4 | 50.5 | 49.4 | 48.2 | 51.1 |

TABLE 5 RESULTS OF TESTS ON 79-15-6 MIXTURE

| | | | | |
|---|---|---|---|---|
| Coal mixture: | | | | |
| Pond Creek, per cent | 75 | 77 | 80 | 79 |
| Low-volatile, per cent | 25 | 18 | 15 | 15 |
| Anthracite, per cent | 0 | 5 | 5 | 6 |
| Coking time 16 hr and 16 min | | | | |
| Run-of-oven coke: | | | | |
| Per cent on $3^1/_2$-in. screen | 30.4 | 36.3 | 38.3 | 37.7 |
| Per cent on 3-in. screen | 50.3 | 54.0 | 57.7 | 54.9 |
| Foundry coke: | | | | |
| Per cent on $3^1/_2$-in. screen | 28.9 | 48.8 | 33.8 | 33.7 |
| Per cent on 3-in. screen | 49.6 | 72.5 | 58.3 | 57.3 |
| Shatter test | 74.9 | 81.0 | 78.9 | 77.2 |
| Per cent cell space | .. | .. | 48.9 | 46.9 |

TABLE 6 BLAST-FURNACE PRODUCTION

| Date | Average tons iron | Average tons scrap | Average tons Fe from ore | Coke rate | Tons anthracite per month |
|---|---|---|---|---|---|
| Dec., 1943 | 795 | 18 | 777 | 1604 | 1434 |
| Jan., 1944 | 799 | 16 | 783 | 1600 | 1659 |
| Feb., 1944 | 794 | 22 | 772 | 1589 | 2102 |
| Mar., 1944 | 814 | 28 | 786 | 1588 | 6156 |
| Apr., 1944 | 828 | 48 | 780 | 1586 | 5907 |

TABLE 7 COKE-OVEN PRODUCTION

| | Yields per ton dry coal mix charged | | | | | |
|---|---|---|---|---|---|---|
| Date | Coke, tons | Gas, cu ft | Light oil, gal | Tar, gal | Ammonium sulphate | Tons anthracite per month |
| Dec., 1943 | 0.766 | 11353 | 3.03 | 8.27 | $NH_3$ used in Thylox plant part of period | 1434 |
| Jan., 1944 | 0.778 | 11270 | 3.01 | 8.45 | | 1659 |
| Feb., 1944 | 0.780 | 11491 | 3.03 | 7.82 | | 2102 |
| Mar., 1944 | 0.786 | 11483 | 2.97 | 7.27 | | 6156 |
| Apr., 1944 | 0.784 | 11576 | 2.88 | 8.22 | | 5907 |
| May, 1944 | 0.788 | 11397 | 2.75 | 7.43 | | 8435 |

coke ovens remained substantially the same because of the increase of high volatile in the coal mixture. The increase in through-put of about 5 per cent could easily be made 10 per cent if we could obtain sufficient coal. Coke-oven production is given in Table 7.

The 95 per cent high-volatile and 5 per cent anthracite coal mixture unexpectedly gave equal results to our regular standard mixture of 75 per cent high-volatile and 25 per cent low-volatile. This indicated that there is the possibility with some coals of substituting anthracite for the low-volatile when the supply of the latter is low. It is also suggested that in case of excess oven pressure, when expanding low-volatile coals are used, relief can be obtained by substituting some anthracite for part of the low-volatile.

We have supplied coke to the following blast furnaces where it has been considered of high quality: Great Lakes Steel Company, Port Colborne, Jones & Laughlin, Carnegie-Illinois (Chicago), Toledo Furnace Company, Inland Steel Company, Youngstown Sheet & Tube.

Blast-furnace and coke-oven production for the months that anthracite coal has been used indicates no marked change from our standard practice. The gains are from the standpoint of supply and cost of coal. There is a greater flexibility in choice of coals and in our case the cost of anthracite was below low- and high-volatile bituminous coals. It can be said that something has been added to our operation.

### COMMENT BY L. L. NEWMAN[11]

The gas-producer tests scheduled for the middle of June, after making the structural modifications which were needed to improve the center of the fuel bed, were completed on June 19, 1944.

Reports and analyses of the coal and ash were not available at the time of writing, and the calculations had not progressed far enough to furnish conclusive quantitative data.

The principal modification which was made on the producer consists of the addition of a telescoping ring inside of the center ring shown in Fig. 10 of the paper. The effect of lowering the ring is to lower the depth of the fuel bed outside of the ring. The fuel bed encompassed by this ring is thus strengthened in relation to the fuel bed surrounding it. By choosing the proper elevation of the inner ring the resistance of the fuel bed to the flow of gases is approximately equalized.

As a result, the through-put of barley anthracite with the aid of the agitator was increased to an extent which approaches the normal through-put of rice anthracite without the aid of the agitator.

However, there is still much to be learned regarding the proper technique of operating the agitator. A series of tests has been projected in which several of the more important variables will be individually considered; included among which will be the effect of the position of the agitator with respect to the combustion zone, the rate of revolution, and the amount and rate of vertical travel of the agitator, the depths of the ash and live-fuel zones, the saturation temperature, etc.

It is hoped that as a result of improvements in the operating technique with barley fuel and the agitator, there will be attained gasification rates equal to those with rice without the use of the agitator. Even if such rates should not be fully attained, it now seems certain that the agitator can provide a means of opening additional markets for a large tonnage of barley for producer fuel, thus displacing rice anthracite for other uses to which the smaller sizes cannot be readily adapted.

### COMMENT BY P. S. SAVAGE[12]

We have just started to use fine anthracite in our coking coal mixture.

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[11] Gas Engineer, Bureau of Mines, Washington, D. C. Comment published by permission of the Director, Bureau of Mines, U. S. Department of the Interior.

[12] Vice-President, Donner-Hanna Coke Corporation, Buffalo, N. Y.

We are at present using 3 per cent of a mixture of No. 4 and No. 5 buckwheat. This is now being used in our regular coke which we are supplying to four blast furnaces operating in this district. Results to date indicate that we can tolerate 3 to 4 per cent of this type material if the ash in the buckwheat can be kept uniform at about 12 per cent.

From laboratory tests we have made, it is indicated that anthracite ground finer than even No. 5 buckwheat would actually show an improvement in coke structure. This is probably caused by the less-fluid plastic zone which results from the introduction of any fine inert material. The gas escaping from the fluid mass thus leaves the plastic zone with heavier cell walls and there are less shrinkage cracks. This theory may not be correct, but it is the writer's idea of why a fine inert material tends to strengthen and increase the size of coke when mixed with coking coal in comparatively small amounts.

Our suggestion in developing the utilization of fine anthracite for coke would be to get the operators who produce fine anthracite to produce a uniform reliable material. To date we have found that the producers of fine anthracite are selling material ranging from 10 to 26 per cent ash. By-product coke producers will simply not tolerate material that is not uniform.

We have now had more than a year's experience in using fine anthracite and have found it possible to use 4 to 5 per cent No. 5 buckwheat of proper quality in blast-furnace coke being used in furnaces producing iron ranging from basic grades to ferrosilicate, without any apparent harmful effects to the furnaces.

### COMMENT BY HOWARD ZELLER.[13]

The success of burning barley mixtures with bituminous coal on stokers depends a great deal upon proper mixing. Also, it is quite essential that the bituminous coal in the mixture be of rather strong coking tendency in order that coke form promptly under the stoker arch to hold the barley coal in the fire bed. If this coking quality is absent, there is a tendency for the barley to blow out of the fire and cause considerable trouble in the boiler.

When using anthracite barley in coking coal mixtures, the question of efficient mixing is even more important than it is in the case of the stokers. Furthermore, the barley size is too large to give good results. It is our opinion that nothing larger than 20 mesh should be used in a coking coal mixture, and that a very efficient mix must be secured. The percentage which can be used, of course, is limited and we do not think that over 5 per cent would be practical. On barley this would require further crushing and the use of a mixing bin or other mixing arrangement.

We wish, also, to call attention to the fact that this will somewhat reduce the production of gas, tars, benzols, etc., but probably only to such extent that it will not be a major consideration.

### AUTHORS' CLOSURE

The authors wish to thank individually each contributor to the discussion. Information has been added that gives interesting and valuable data, thus greatly improving the published material on the subject. It is hoped that future work will remove some of the controversial phases, particularly in connection with the use of fine anthracite in the product of coke.

J. F. BARKLEY.[14]
WILLIAM SEYMOUR.[15]

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[13] Jamison Coal and Coke Company, Greensburg, Pa.

[14] Chief, Division of Solid Fuels Utilization for War, Bureau of Mines.

[15] Chemical Engineer, Bureau of Mines, Pittsburgh, Pa.

# Citizenship

TO THE EDITOR:

I have just finished reading the June, 1945, issue of MECHANICAL ENGINEERING. I skimmed over the technical articles in the front part of this issue. The hot humid weather in this part of the world wilts one's ambition for reading of that sort.

I read K. Y. Chen's article on page 398, "How Can China Be Industrialized." I wondered if the $10,000,000 that Chen wants to borrow was figured on the experience we are undergoing now with the equipment we are taking into China to fight the Japs. I guess not, as Chen's article conveys the impression that everything purchased with all this money is expected to arrive on the job and be used for the purpose for which it is intended.

I finished reading Chen's dream of a future China, and found myself into Roy V. Wright's paper, "The Engineer's Status in the Community." Citizenship and its helpful and practical application by the engineer has been one of Dr. Wright's hobbies for many years. His talents, character, and abilities are especially adapted to public life. His paper is emphasized by President Bailey's appeal on the President's Page, "The Engineer's Duty as a Citizen."

Knowing the difficulties in China which are basically ones of honesty and citizenship of the self-sacrificing kind, I wonder if including Dr. Wright's paper and President Bailey's message in the same issue with K. T. Chen's paper was intentional or just an accident in the make-up of the June issue. I laid my copy of MECHANICAL ENGINEERING aside to read the August 2, 1945, issue of the *CBI Roundup*, a weekly paper published by the soldiers in this theater.

I read where Senator Theodore Bilbo of Mississippi writes a letter to Miss Rose Piccolo, an employee of the Brooklyn Navy Yard, addressing her "Dear Dago" and as good as telling her that affairs of public interest were none of her business. The *Roundup* report states that Miss Piccolo had one brother killed in action, has another lying wounded in a hospital, and a third now in Germany, all with the U. S. Army. It is no use wasting space to tell why what goes on in Mississippi, Britain, or Russia is not Miss Piccolo's business, my business, and your business. Being in two wars, I have learned that what goes on in Europe and Asia is very much my business. As every engineer knows developments in communications and in transportation have made your business everybody's business. The closeness of world affairs has broadened the scope and duty of citizenship.

Dr. Wright reports that only 19 sketches were received on his "measuring stick" survey. We all know that most engineers are interested and working in some sort of community activity. From my personal observation and experience, the average engineer will interest himself in "outside activities" up to the point where he finds himself getting into politics. An engineer's education, training, and inclinations make him want to avoid the unpleasantness that politics seems to lead to. He draws an imaginary line as to how far and no further his activities in citizenship will carry him. This is not because of lack of courage in his character or because he is afraid of a fight. To an engineer a fact is a fact, and not something to be distorted or misrepresented. Here is where his lack of education and training in finesse, diplomacy, or whatever else you want to call it, shows up. The thing that is first in his mind is not to argue. This is why engineers have to pay money to lawyers and other professions, better trained (if you desire to call it that) in the "science of human relations." The Engineer's Civic Responsibilities Committee has a big job on its hands.

One of the miracles of this war has been the ease and speed with which lawyers, bond salesmen, and the like have become experts in transportation. Their individual rewards in the form of promotions and medals have far exceeded those made to the railroad, highway, and marine men who have been sweating the job through and doing a surprisingly efficient job in spite of asinine and "cockeyed" orders and directives which, if carried out, would have meant failure. With the rapid expansion of transportation activity, the engineer and his technical associates are still just about where they were at the beginning of this war. The engineer is simply not a "front office politician." In the Army we call them "headquarters politicians" and "empire builders." I know of one office where there is not a single man with transportation experience or training heading up a department, yet this office is theoretically charged with the successful administration of a large and important transportation system. Fortunately, it never has actually functioned, because others have assumed the duties, while the main office is organized to get the credit.

Citizenship requires a lot of personal characteristics and traits that the average engineer does not possess. In times of expansion he cannot compete with the smooth talker and politician who takes his job away from him but still leaves him holding the bag when it comes to getting the job done. So much of this has occurred in recent years that many engineers have developed an inferiority complex with respect to this special field of human relations. If he is unable to hold his own in the interior politics of the organization in which he is employed, you can rest assured he is going to be chary about sticking his neck out into the broader and more strange politics of community activity and other things we classify under the general heading of citizenship.

I am heartily in accord with Dr. Wright's ideas and objectives. What I have written is something for the Engineers' Civic Responsibilities Committee to consider as it formulates its citizenship program.

MARION B. RICHARDSON.[16]

TO THE EDITOR:

I have read Col. Marion B. Richardson's letter with keen interest. Incidentally, he is entitled to much credit for the fine service he has rendered in the Southeast Asia area of our war activities. I also know full well of his interest and participation in civic affairs and local politics in those communities in which he has lived.

I cannot agree, however, with his statement that "the average engineer would interest himself in 'outside activities' up to the point where he finds himself getting into politics." The facts as thus far developed by our A.S.M.E. Citizenship Committee certainly do not substantiate his statement. Engineers, like other professional men, are so deeply engrossed in their professional activities that most of them do not take much or any interest in civic affairs, and yet this is what every reasonably intelligent citizen should do in a republic, or representative democracy such as ours. If citizens are indifferent to their duties and responsibilities, then the demagogues and unscrupulous politicians take over and exploit the community to their personal advantage.

Nor can I agree with his statement that "citizenship requires a lot of personal characteristics and traits that the average engineer does not possess." Young engineers in these days have excellent educational advantages; most of them are equipped with a college training superimposed upon the successful completion of high-school or junior-college courses. They are regarded as being well above the average in intelligence. The growing complication of governmental problems, for which engineers and scientists are to a considerable degree responsible, makes it necessary to approach such problems in an engineering attitude. Let me quote from an address by President Herbert Hoover when he was awarded the first Hoover Medal:

"Every county government, every municipal government, every state government, and the federal government itself is engaged in constant attempt to solve a multitude of public relationships to these tools which the engineers by their genius and industry constantly force to the very doorstep of government. And in solving these problems we have need of a large leavening of the engineering knowledge and engineering attitude of mind and engineering method. These problems of public relation are unsolvable without the technical knowledge of the engineers. They are unsolvable without the fundamental engineers' approach to truth. That is, first to determine the facts, arrange these facts in proper perspective, and then distill truth from them in the retort of experience. .......I have a high appreciation of the other professions, but the engineers, I insist, have a contribution to make to public service and they have an obligation to give that contribution."

The engineer with his training and logic is in an excellent position to be helpful in civic and government affairs. The difficulty is that he has never been trained to recognize this fact and that is something our committee is trying to encourage. The promotion of humanistic-social studies by the Society for the Promotion of Engineering Education is also heartening.

It is not our purpose to try to make politicians of engineers, but we do insist that educated and well-equipped citizens should assume their reasonable share in a "government of the people, by the people, for the people."

ROY V. WRIGHT.[17]

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[16] Mem. A.S.M.E.

[17] Past-President and Honorary Member, A.S.M.E. Chairman, A.S.M.E. Engineers' Civic Responsibilities Committee.

# Filler Metal Specifications

TO THE EDITOR:

The purchase specifications which have been issued under the heading "Filler Metal Specifications" by the American Welding Society may fulfill a function as a buyer's guide. That is open to question. They are not a technical standard for arc-welding electrodes. Such a technical standard is a crying need of the welding industry.

This problem of a proper standard has been considered by the Filler Metal Committee of the American Welding Society many times during the last twenty-five years without working out a usable solution. Because of this fact, a great deal of welding which should be used is not now done. A great many products which could be produced more economically, more quickly, and more safely are still made by the less efficient, less safe, methods. When a standard which will be easily and universally usable is developed and promulgated, the next step in the progress of arc welding will have been taken.

Technical standards are always necessary in all engineers' fields. If technical standards in the electrical and mechanical-engineering field were lacking, the progress in these fields would have been small. It is only by proper, usable, and accurate standards that any successful approach to an engineering design can be made. This is just as true of welding as it is of designing a bridge.

In approaching the problem of a proper technical standard for arc-welding electrodes, it must be remembered there is much less difference between the deposits of any of the commercial shielded-arc mild-steel electrodes than there is in various steels that these electrodes have for years successfully welded. The deposited metal from any commercial shielded-arc electrode for welding mild steel is very little different from the deposit of any other shielded-arc electrode. Every electrode deposit which is made for welding mild steel could be accurately placed in the S.A.E. 1010 classification.

However, the purchase specifications of the American Welding Society, which is their only approach to any standard covering electrodes, sets up limitations in all these electrodes which results in endless misunderstanding on the part of the user. Differences of no possible importance between the various electrodes are blown up and designated as classes. Not only that, but electrodes which will fall into exactly the same classification under these specifications are by rule eliminated from being put in the same classification. These purchase specifications speak hopefully, however, that they may allow these duplicate electrodes to eventually be classified as like.

The unfortunate part of the whole matter is the user's reaction. He feels that if the manufacturer goes to such outlandish efforts to establish a nonexistent difference he must be very careful if he is to use the electrode. He suspects a "nigger in the wood pile." When he cannot understand the reasons for the claimed differences he is frightened and leaves all welding alone.

Arc welding should not be placed under such a handicap. Arc welding is not an untried operation. It has a long period of successful application on all manner of structures and has acquitted itself very much better than has the parent metal which it joined.

Certainly after a record of this kind there should not be questions as to the reliability of a product placed in the minds of the users. The metal that is deposited from mild-steel electrodes is more accurately and carefully selected than the steel it joins. It also does not have the laps, seams, and lamination that occasionally are present in the parent metals.

In the light of this history, it is obvious the differentiation between various classifications of electrodes which is now developed in the present A.W.S. purchase specifications cannot be a quality guide.

The only differences in the operating characteristics of various shielded-arc electrodes has to do largely or entirely with customer preference. These differences have to do with the quantity and fluidity of the slag and with the relative division of the heat between the electrode and the parent metal which determines its penetration. It has little to do with the characteristics of the metal itself. It has to do largely with the user's preference, as is true in the case of color of body or the size of the engine of an automobile. It does not have anything whatsoever to do with the safety or reliability of the weld.

It is obvious also that what is required of an electrode is to make a joint between two pieces of parent metal which will join them together, preferably with metal which would exactly duplicate the parent metal. However, in the light of present knowledge this is an impossibility because the deposit from the electrode is more dense than is the parent metal, hence the deposit is stronger. This means, of course, the weld will always break the plate in tension if it is of equal section. This greater reliability compared to any other method of joining two plates should not be considered a handicap, it is a guarantee.

The only other important characteristic of the deposit is ductility. Elongation in the outside fibers of 25 per cent without fracture is many times more than it will ever be called on to have in actual service. Such a minimum is more than ample under all usable conditions.

From this explanation it is rather obvious what a proper technical standard should be. It should specify a test easy to make and applicable by anyone who does welding to determine the ductility and relative strength.

If we have these two standards in the deposit, certainly there are no other characteristics which will be of importance in any weld. The strength and ductility will be much more than any riveted joint can possibly give, yet rivets have been used for generations with entire success. Welds are a long step beyond rivets, obviously, in both strength and ductility.

It is a simple thing to make this test. Weld two pieces of plate together, pull them to prove that no break will occur in the weld, then bend the weld to see that it will elongate 25 per cent in the outside fibers of the weld metal. The test then is complete and the results definite.

This is a usable, safe, and proper technical specification for the testing of electrodes. This will remove all question regarding quality of the deposit from the minds both of the manufacturer and user.

The only difficulty in the adoption of such a standard, seemingly, is that it is simple and quickly usable, not complicated and expensive. Most fundamental law that is decisive has always been simple. The complication is hung on to it by those who feel that simplicity cannot be esoteric. They may have something there.

J. F. LINCOLN.[18]

## Magnesium in Aircraft

### COMMENT BY ARCHIBALD BLACK[19]

In Table 8 of his paper,[20] J. C. Mathes draws comparisons between the structural efficiency of several different materials. Without questioning the accuracy of the comparison as it applies to the case in question, it should be remembered that the size of the structure has an all-important bearing upon the results that will be attained. In general, the lighter weight, even though lower strength, materials are most efficient for small structures, and the higher strength, even though heavier, materials become the more efficient for large structures. Thus, we usually find that small airplanes are lightest when built of plywood and intermediate sizes are lightest when built of magnesium or aluminum alloys. For very large airplanes, high-strength steel may prove lightest of all. This is because of the structural problems that arise when we find paper-thin sheets are necessary if we are to build small structures of a high-strength material.

## Corrections

TO THE EDITOR:

This is to inform you that Equation [1] of my paper[21] "On Fatigue Failure Under Triaxial Static and Fluctuating Stresses and a Statistical Explanation of Size Effect," has been discovered to be incorrect. Correctly stated, it would read:

$$\sigma_i = S_i K \left[ 1 - \left( 1 - \frac{2\sigma'}{E} \right)^{2n_i} \right] + \sigma_{(i-1)} \left( 1 - \frac{2\sigma'}{E} \right)^{2n_i}$$

As the purpose in stating Equation [1] was to show that a relationship between the quantities involved exists, this result will not affect the remainder of the paper.

FRANKLIN H. FOWLER, JR.[22]

TO THE EDITOR:

The writer wishes to correct typographical errors in his paper "Diamond Cutting Tools" published in the June, 1945, issue of MECHANICAL ENGINEERING.

On page 379 the last three lines of text directly above the heading "References" should read.

"with $z_1 = x_1 \cdot \tan w$, $z_2 = y_1 \cdot \tan v$ and $y/x = \tan \delta_1'$ when replacing sin $w$ by tan $w$ and sin $v$ by tan $v$ we obtain the relation $\tan \lambda = \cos \delta_1' \tan w - \sin \delta_1' \cdot \tan v$."

PAUL GRODZINSKI.[23]

In the caption to the illustration on page 611 of the September issue of MECHANICAL ENGINEERING, the temperature should read "1500 F" and not "15000 F."

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[18] President, The Lincoln Electric Company, Cleveland 1, Ohio. Mem. A.S.M.E.

[19] Manager, Mechanical Engineering Department, Simmonds Aerocessoris, Inc., Long Island City, N. Y.

[20] "Magnesium Design Considerations and Applications," by J. C. Mathes, Mechanical Engineering, July, 1945, pp. 468–472.

[21] Trans. A.S.M.E., vol. 67, 1945, pp. 213–216.

[22] Structures Engineer, Propeller Division, Curtiss-Wright Corporation, Caldwell, N. J. Jun. A.S.M.E.

[23] Manager, Research Department, The Diamond Trading Company, Ltd., London, England.

# REVIEWS OF BOOKS

*And Notes on Books Received in the Engineering Societies Library*

## Chemistry of Coal Utilization

Chemistry of Coal Utilization. Prepared by the Committee on Chemical Utilization of Coal, Division of Chemistry and Chemical Technology, National Research Council, H. H. Lowry, Chairman. John Wiley & Sons, Inc., New York, N. Y., Chapman & Hall, Ltd., London, Eng., 1945. Cloth, 2 volumes, $6\frac{1}{8} \times 8\frac{1}{2}$ in., 920 pp. and index and 948 pp., and index, illus., $20.

Reviewed by Bertrand A. Landry[1]

THE title of this outstanding reference work is in the nature of a minor understatement. Full attention has also been given to the origin, petrography, and classification of coal, and to the physics and principal engineering aspects of coal utilization, although the chemical viewpoint is, of course, closely maintained.

Briefly stated, the work can be described as a critical review of the published literature on the properties of coal and on its utilization, both in the United States and abroad. But it is much more than that. Each of the 33 authors and Dr. Lowry have contributed, in their respective chapters, much creative thinking in the interpretation and an extremely logical and satisfying arrangement of the material. Practical aspects have been enriched from the experience of the several contributors in the field of utilization. The work is truly provocative and inspiring, as well as informative.

Volume 1 contains 24 chapters and covers the subjects of origin, classification, and petrography of coal; its calorific value, hardness, strength, and grindability; its plastic, agglutinating, agglomerating, swelling, and general physical properties; its chemical nature as determined by halogenation, oxidation, reduction, and hydrolytic reactions; the forms and occurrence of sulphur, nitrogen, and mineral matter; and the fusion, flow, and clinkering of ash. Chapters are devoted to the cleaning of coal, moisture in coal, changes during storage, the action of solvents, and the results obtained from vacuum distillation. The last 89 pages discuss industrial coal carbonization, the effect of temperature and rate of heating on yields, the pretreatment of coal for carbonization, and coke properties.

Volume 2 is divided into 16 chapters. The subject of carbonization is continued with discussions on gas from coal, the cleaning of the gas and recovery of gaseous by-products; on recovery of light oils and removal of other constituents, on the nature of coal tar, and on the subject of ammoniacal liquors. Utilization aspects of coal gas, combustion in fuel beds, and combustion of pulverized coal are presented. The interesting matter of direct generation of electricity from fuel cells, despite its remote applicability, is adequately treated. This is followed by a review on gas producers and water-gas sets. The final three chapters are devoted to the hydrogenation of coal and tar, the synthesis of hydrocarbons from water gas, and the synthesis of methanol. The first two of these subjects are presently very much in the limelight; the last has revolutionized the industry of "wood" alcohol.

The list of subjects treated will make it apparent that the scope of the work is comprehensive. It can be said that never before has so much information on the properties and uses of coal been brought under two sets of covers. Thousands of references are cited; viewed only from the bibliographic point of view, this compendium will prove invaluable. However, each reader will find, in his field, an abundance of new material extending from the historical aspects to the applicability of developments, and often comprising a synthesis of the theoretical approaches, of great interest.

The physical make-up of the two books deserves the highest praise in the choice of type, quality of illustrations, and absence of errors. Each volume contains the complete book, author, and subject indexes of the entire work. Reference has been further facilitated by continuing the pagination through volume 2.

No claim is made for complete agreement of interpretation between authors in chapters devoted to allied subjects in which common source material is used. This would not seem to hinder the value of the work but rather to emphasize points for further study. Current activity in the field of coal research has never been so great. Many important developments which arose as a consequence of war emergencies or in relation to active preparation for the postwar period are now, or shortly will be, available in the literature. It is earnestly hoped that a third volume will be prepared within a few years to round out the usefulness of this treatise. Meanwhile, no one genuinely interested in coal and its use can afford not to have access to this invaluable compilation.

## Budgeting for Management Control

Budgeting for Management Control. By Floyd H. Rowland and William H. Harr. Harper & Brothers, New York, N. Y., 1945. Cloth, $5\frac{5}{8} \times 9\frac{1}{4}$ in., 378 pp., 112 figs., $4.

Reviewed by Harold V. Coes[2]

IN their philosophy of budgeting the authors bracket planning with budgets, which is highly important if budgetary procedures are to provide reliable means for over-all control.

They point out quite validly that the practice of comparing figures for prior years with current data, in which underlying conditions are not comparable, is too many times of no real value as a basis for management policies or decisions.

They make the point that budgetary control provides the means for directors to secure the fundamental information essential to the determination of policies; that budgetary control embraces every phase of industrial planning. The planning would apply as well, with some exceptions, to budgetary control applied to other commercial enterprises.

The authors quite properly state that the organization must be arranged to permit suitable delegation of authority and responsibility, with the budget director reporting to the president.

They point out the seventeen fundamental steps that must be taken in connection with the installation of budgetary control, and assert that standard costs are an ideal basis for budgets.

They define the duties of directors and officers with respect to budgetary procedure and responsibility.

Quite properly they state that the management report's structure is determined by the organization chart. They show forms for the master budget, sales, advertising, operating, plant, and other budgets, and the variations between actual and budget figures.

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[1] Assistant Supervisor, Fuels Division, Battelle Memorial Institute, Columbus, Ohio. Mem. A.S.M.E.

[2] Vice-President, Ford, Bacon & Davis, Inc., New York, N. Y. Past-President and Fellow, A.S.M.E.

They discuss the basic requirements of a chart of accounts to meet the fundamental requirements of budgetary control.

Several chapters deal with company objectives as to products, sales volume, and quotas, and financial return, and attention is called to the fact, so often overlooked, that budgets are based on reliable sales forecasts. The authors apply the techniques and methods of forecasting to a hypothetical company. They point out the various published indexes that are available and show the graphic method of correlating indexes.

The first six chapters deal with (1) the establishment of the company objective or over-all plan; (2) the design of an organization pattern to carry out the objectives; (3) the determination of the product lines; and (4) the development of the company's place in its industries and the establishment of sales quotas.

The next chapter deals with the examination of the company's resources, plant, equipment, organization, inventories, and capital requirements.

The eighth chapter discusses the preparation of the preliminary operating statements and analysis of required return on capital. The following chapter shows the application of the break-even point chart to the hypothetical company's problems.

Chapter 10 explains the budgets, shows a graphic budget flow chart, and outlines the budgetary procedure for individual budgets.

Preliminary budgetary installation is next discussed and attention called to the fact that time is required to successfully install budgets in a going concern. They might also have laid stress on patience as well as time.

Expense standards for use in variable budget tables are discussed at length as a means for (1) measuring actual performance to avoid refiguring the budget; (2) formulating a basis for supervisory incentives; (3) establishing budgets quickly without reference to historical expense data; (4) calculating variations from the standard accounts affecting cash; and (5) establishing the one hundred per cent level for overhead distribution. This is a very useful chapter and is well illustrated with suitable forms.

Chapters 13 through 17 discuss the sales, production, and plant expense items and the summary budgets.

Chapter 18 explains standard costs for manufacturing and distribution expenses and their relation to and use in budgets and budgetary control.

The next two chapters are useful, particularly the one on distribution-expense budgeting and control, with the basis for establishing the one hundred per cent expense tables. Too often distribution expenses get out of line.

Variances are dealt with in chapter 20. The point is well made that any system of standard costs (they should be current standard, not basic standard), coupled with budgetary control, should be tied in with the general books for reliability and completeness.

Chapter 21 deals with the control of distribution activities and this is a helpful chapter.

In order to stimulate the enforcement of expense budgets chapter 22 presents the necessity for incentives, particularly in the lower echelons of management. Calculations of supervisory incentive earnings for the hypothetical company are presented.

The scope and purpose of a budget manual is set forth in the final chapter. This, too, is a timely and helpful chapter.

In the opinion of one who has had considerable experience with budgets, the book will serve a useful purpose, particularly for smaller and medium-size industrial companies which have had no experience in budgeting, yet would be well advised to adopt budgetary control and procedure as a means for the guidance of the management and of securing effective control in the difficult period ahead when intensive competition will reign.

The book is well organized, and well illustrated, and the subject matter is presented in readily understandable and usable form.

# Books Received in Library

INDUSTRIAL PLASTICS. By H. R. Simonds. Third edition. Pitman Publishing Corporation, New York, N. Y., and Chicago, Ill., 1945. Linen, $6 \times 9^{1}/_{4}$ in., 396 pp., illus., diagrams, charts, tables, \$5. The use of plastics as engineering materials is emphasized in the full treatment of the fabrication as well as the basic manufacturing processes of plastics. Important new developments and processes are covered in this revised edition, which also devotes a chapter to foreign practice. Design information, suggestions for new applications and markets, and a revised trade-name index provide further useful material for the student or practical user.

MAKING PATENT DRAWINGS. By H. Radzinsky. The Macmillan Company, New York, N. Y., 1945. Cloth, $7^{1}/_{4} \times 10^{1}/_{4}$ in., 96 pp., diagrams, tables, \$3. Explicit instructions are given for shading, placement of numerals and figures, and other special techniques in making drawings both for patents and for trademarks. Brief general drawing instructions are included, and a separate chapter is devoted to common causes for rejection. The rules of the U. S. Patent Office relative to drawings are appended.

MASTERS OF MASS PRODUCTION. By C. Borth. Bobbs-Merrill Co., Indianapolis, Ind., and New York, N. Y., 1945. Cloth, $5^{3}/_{4} \times 8^{3}/_{4}$ in., 290 pp., illus., \$3.50. In narrative form the author first briefly presents the early efforts of American inventors and manufacturers who played their parts in the development of the system currently known as mass production. The major part of the book is devoted to the characteristics, methods, and achievements of the men who applied this mass production, under pressure of the war, to the manufacture of the new weapons, vehicles, and planes needed. The feeling of the whole book is—this is America in action.

NEW PLASTICS. By H. R. Simonds and M. H. Bigelow, assisted by J. V. Sherman. D. Van Nostrand Co., Inc., New York, N. Y., 1945. Cloth, $5^{1}/_{2} \times 8^{3}/_{4}$ in., 320 pp., illus., diagrams, charts, tables, \$4.50. This book presents the available information on all important plastics materials developed since 1940. Separate chapters are devoted to the new fibers, new adhesives, new laminating materials, new applications of wood and paper, new forms and coatings. New and improved processes and applications for established plastics are covered, and the trend of the plastics industry is demonstrated as indicated by summarized statistical and technical information.

SCIENCE IN PROGRESS, fourth series (Society of the Sigma Xi devoted to the Encouragement of Research in Science, National Lectureships 1943–1944). By W. R. Miles and others, foreword by L. L. Woodruff, edited by G. A. Baitsell. Yale University Press, New Haven, Conn.; Humphrey Milford, Oxford University Press, London, England, 1945. 331 pp., illus., diagrams, charts, tables, \$3. This fourth volume of a series contains eleven reports by the investigators themselves describing work in pure science that is closely linked to advances in the science of war and the art of living. The wide range of topics includes research on nerve cells and impulses, magnetic approach to absolute zero, vacuum chemistry, blood derivatives, atom mechanics, and the psychological aspects of military aviation.

THEORY OF FLIGHT. By. R. von Mises. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1945. Cloth, $5^{3}/_{4} \times 9$ in., 629 pp., diagrams, charts, tables, \$6. All phases of the theory of airplane flights are covered in this comprehensive work for intermediate students The material is divided into five sections: equilibrium and steady flow in the atmosphere; the airplane wing; propeller and engine; airplane performance; airplane control and stability. The book aims to develop interest in and understanding of the fundamental ideas that underlie the design and the operation of modern aircraft.

Treatise on the THEORY OF BESSEL FUNCTIONS. By G. N. Watson. Second edition. The Macmillan Co., New York, N. Y., The University Press, Cambridge, England, 1945. Cloth, $7^{1}/_{4} \times 10^{1}/_{4}$ in., 804 pp., diagrams, tables, \$15. The mathematical aspects of Bessel functions are discussed with two main objects: The development of applications of the fundamental theory of functions of complex variables; the compilation of a collection of results which would be of value to the increasing number of mathematicians and physicists who encounter Bessel functions in their investigations. An extensive bibliography is included.

# A.S.M.E. NEWS

*And Notes on Other Engineering Activities*

## Tentative Program of A.S.M.E. 1945 Annual Meeting

### New York, N. Y., November 26–29, 1945

*Headquarters, Hotel Pennsylvania*

### SUNDAY, NOVEMBER 25

**9:30 a.m.**

Meeting of Executive Committee of Council

**12:15 p.m.**

Council Luncheon

**2:30 p.m.**

Meeting of Council

**8:15 p.m.**

Meeting of Council

### MONDAY, NOVEMBER 26

**9:30 a.m.**

Meeting of Council

**Industrial Instruments & Regulators (I)**

Dynamic Behavior and Design of Servomechanisms, by G. S. Brown, servomechanism laboratory, Massachusetts Institute of Technology, Cambridge, Mass.*

Unified Symbolism for Automatic Regulation, by G. A. Philbrick, The Franklin Institute, Philadelphia, Pa.*

**Heat Transfer (I)**

Free Heat Convection Through Enclosed Plane Gas Layers, by Max Jakob, Armour Research Foundation, Chicago, Ill.

The Effect of Heat Loss on the Performance of Exchangers With Interconnected Walls, by P. R. Trumpler, M. W. Kellogg Company, New York, N. Y.

**Fuels (I)**

Estimating and Evaluating Army Fuel Requirements, by R. E. Biller, Repairs and Utilities Division, Corps of Engineers, U. S. Army, Washington, D. C.

Example Section for a Smoke Regulation Ordinance by Model Smoke Law Committee, J. F. Barkley, Chairman

**Aviation (I)—Applied Mechanics (I)**

Parallel Columns With Common Lateral Supports, by Henry L. Langhaar, Consolidated-Vultee Aircraft Corp., San Diego, Calif.*

MONDAY (*Continued*)

**9:30 a.m.**

The Flutter of a Uniform Cantilever Wing, by Martin Goland, Airplane Division—Research Laboratory, Curtiss-Wright Corp., Buffalo, N. Y.*

An Empirical Approach to the Fatigue-Strength Analysis of Structures, by Henry W. Foster and Victor Seliger, research engineers, Lockheed Aircraft Corporation, Burbank, Calif.*

Local Stress Distribution in Cylindrical Shells With Circular Symmetry, by Leon Beskin, Consolidated-Vultee Aircraft Corporation, Nashville Division, engineering department, Nashville, Tenn.*

**Graphitization**

The Joint A.S.T.M.-A.S.M.E. Research Committee on Effect of Temperature on the Properties of Metals, sponsor. The Graphitization of Steel Piping

**Lubrication**

Factors Influencing the Wear of Carbon Brushes Under High-Altitude Conditions, by W. E. Campbell, member of technical staff, Bell Telephone Laboratories, Summit, N. J.

Paper by Wm. A. Zisman, U. S. Naval Research Laboratory, Anacostia, Washington, D. C.

Co-Ordinated Data on Viscosity of Lubricants at High Pressures, by M. D. Hersey, Massachusetts Institute of Technology, Cambridge, Mass.

**12:15 p.m.**

**General Luncheon**

*Auspices of Committee on Education and Training for the Industries and Management Division*

Speaker to be announced

**2:30 p.m.**

**Education and Training (I)**

Training for Leadership, by Brig. Gen. H. R. Kutz, U.S.A., Chief Military Training Service, Office of Chief of Ordnance, U. S. Army, Washington, D. C., and Rear Admiral James L. Holloway, Jr., U. S. Navy, Assistant Chief, Naval Personnel for Demobilization, Navy Department, Washington, D. C., and D. C. Prince, vice-president, General Electric Company, Schenectady, N. Y.

MONDAY (*Continued*)

**2:30 p.m.**

**6:00 p.m.**

**Rocket Dinner**

Topic: Rockets and Jet Propulsion

Basic Concepts, by G. Edward Pendray, Secretary, The American Rocket Society, New York, N. Y.

The Liquid-Propellant Rocket Motor, by Lovell Lawrence, Jr., president, Reaction Motors, Inc.

**8:15 p.m.**

**Industrial Instruments and Regulators (II)—Aviation (II)**

New Developments in Combination Controls, by John W. Kelly, chief engineer, Aircraft and Transport Division, Adel Precision Products Corporation, Burbank, Calif.*

Transient Recording as a Tool in Mechanical Development, by Sidney Westman and Edward Partington, development engineers, Pacific Division—Bendix Aviation Corporation, Los Angeles, Calif.*

Effect of Measurement Dead Time in the Control of Certain Processes, by D. P. Eckman, Brown Instrument Co., Philadelphia, Pa.*

**Power (I)—Industrial Instruments and Regulators (III)**

*Industrial Instruments and Regulators Divisions and Joint Research Committee on Boiler Feedwater Studies*

Operation of Montaup Boiler, by G. U. Parks, Somerset Station, Montaup Electric Company, Fall River, Mass., F. S. Clark, Stone & Webster Engineering Corporation, Boston, Mass., W. S. Patterson, Combustion Engineering Co., Inc., New York, N. Y.

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* To be preprinted for 1945 Annual Meeting.

## MONDAY (*Continued*)

**8:15 p.m.**

Instrumentation of Montaup Boiler, by E. B. Powell, Stone & Webster Engineering Corporation, Boston, Mass., W. D. Bissell, Somerset Station, Montaup Electric Company, Fall River, Mass.

Special Problems Investigation, by B. J. Cross, Combustion Engineering Co., Inc., New York, N. Y.

Feed Treatment, by R. E. Hall, E. P. Partridge, and W. W. Cerna, Hall Laboratories, Inc., Pittsburgh, Pa.

### Fuels (II)

A New Method of Pulverizing and Drying Coal, by A. D. Singh, Institute of Gas Technology, Chicago, Ill., and J. I. Yellott, director of research—Locomotive Development Committee, Baltimore, Md.

German Production of Synthetic Liquid Fuels, by W. C. Schroeder, chief, Office of Synthetic Liquid Fuels, Bureau of Mines, Washington, D. C.

### Management (I)

The Optimum Areas of Collective Bargaining, by Lee H. Hill, McGraw-Hill Publishing Co., New York, N. Y., and E. T. Cheyfitz, national chairman, International Association, Mine, Mill, and Smelter Workers of America, CIO.

### Production Engineering (I)

Fabricated Assemblies, by George Snyder, chief engineer, Lukenwald Inc., Coatesville, Pa.

The Function of the Electrical Engineer as the Collaborator on Machine Design, by Robert H. Clark, Warner and Swasey Co., Cleveland, Ohio

### Metals Engineering

Failure of Ductile Metals in Tension, by G. Sachs, G. Espey, and J. D. Lubahn, Case School of Applied Science, Cleveland, Ohio

## Registration Fee for Non-Members at the 1945 Annual Meeting

There will be a registration fee of $2 for nonmembers attending the 1945 Annual Meeting. For nonmembers wishing to attend just one session (except evening sessions or meal meetings) the fee will be $1. This is in accordance with the ruling of the Standing Committee on Meetings and Program.

Members wishing to bring nonmember guests (male) may avoid this fee by writing to the Secretary of the Society before November 15 asking for a guest-attendance card for the Annual Meeting. The card, upon presentation by a guest, will be accepted in lieu of the registration fee. Guests are limited to *two per member*.

## MONDAY (*Continued*)

**8:15 p.m.**

The Necking of Tensile Test Specimens, by G. Sachs and J. D. Lubahn, Case School of Applied Science, Cleveland, Ohio

The Necking of Thick-Walled Tubing Subjected to Internal Pressure, by G. Espey, Case School of Applied Science, Cleveland, Ohio

### Applied Mechanics (II)

Dimensional Analysis and Presentation of Data in Fluid Flow Problems, by E. R. Van Driest, Massachusetts Institute of Technology, Cambridge, Mass.*

Fluid-Flow Types Resulting From Two-Dimensional Flows by Superposition of a Constant Normal Velocity, by H. Poritsky, General Electric Company, Schenectady, N. Y.

Friction in Pipe for Subsonic and Supersonic Flow of Air, by J. H. Keenan, Massachusetts Institute of Technology, Cambridge, Mass., and E. P. Neumann, Massachusetts Institute of Technology, Cambridge, Mass.

A Study of the Flow of Plastics Through Pipes, by R. C. Binder, professor of mechanical engineering, School of Mechanical Engineering and Aeronautics, Purdue University, W. Lafayette, Ind., and J. E. Busher, engineering department, Tube Turns, Inc., Louisville, Ky.*

## TUESDAY, NOVEMBER 27

**9:30 a.m.**

### Rubber and Plastics (I)

*Rubber and Plastics Division jointly with the Rubber and Plastics Division of the Metropolitan Section, A.S.M.E.*

Physical Properties of Resin Impregnated in Plaster of Paris, by John Delmonte, Plastics Industries Technical Institute, Los Angeles, Calif.

Effect of Molding Pressure and Resin on Results of Short-Time Tests and Fatigue Tests of Compreg, by W. N. Findley, W. J. Worley, and C. D. Kacalieff, University of Illinois, Urbana, Ill.*

Advances in Plastics During 1945, by R. J. Moore, Bakelite Corporation, New York, N. Y.

### Oil & Gas Power (I)

On the Kadenacy Effect, by P. H. Schweitzer, The Pennsylvania State College, State College, Pa.

Analysis of Intercooled Supercharging, by Ralph Miller, Nordberg Manufacturing Co., Milwaukee, Wis.

### Applied Mechanics (III)

Nonlinear Theory of Elasticity With Small Deformations, by E. Sternberg, Illinois Institute of Technology, Chicago, Ill.*

## *Official Notice*

### A.S.M.E. Business Meeting

THE Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held on Monday afternoon, November 26, 1945, at 4:00 p.m. at the Pennsylvania Hotel, New York, N. Y., as a part of the Annual Meeting of the Society.

## TUESDAY (*Continued*)

**9:30 a.m.**

Tension Tests at Constant True Strain Rates, by C. W. MacGregor and J. C. Fisher, Massachusetts Institute of Technology, Cambridge, Mass.*

A Velocity-Modified Temperature for the Plastic Flow of Metals, by C. W. MacGregor and J. C. Fisher, Massachusetts Institute of Technology, Cambridge, Mass.*

Stresses in Rotating Disks at High Temperatures, by A. S. Thompson, Westinghouse Electric Corporation, Lester, Pa.*

### Critical-Pressure Steam Boilers—Power (II)

Stress-Rupture Characteristics of Various Steels at 1200 F, by J. T. Agnew, research assistant, G. A. Hawkins, and H. L. Solberg, Purdue University, W. Lafayette, Ind.

### Management (II)

Organization Structure as a Management Tool

- The Monoproduct Plant, by General R. W. Johnson, chairman of board, Johnson and Johnson Co., New Brunswick, N. J.
- The Multiproduct Plant, by H. LeR. Emmet, works manager, General Electric Co., Erie, Pa.
- Summary of Organization Principles, by C. E. James, associate counselor, Stevenson, Jordan, and Harrison, Inc., New York, N. Y.

### Wood Industries (I)

Conveyer Systems in Furniture Plants, by E. S. Davidson, Davidson Engineering Service, Winston Salem, N. C.

Rate of Temperature Change in Short-Length Round Timbers, by J. D. MacLean, U. S. Forest Products Laboratory, Madison, Wis.

Glue Line Stresses in Laminated Wood, by A. G. H. Dietz, Massachusetts Institute of Technology, Boston, Mass., and Henry Grinsfelder, Resinous Products and Chemical Company, Philadelphia, Pa.

### Industrial Instruments and Regulators (IV)—Aviation (III)

Mechanical Oscillators and Their Electrical Synchronization, by B. J. Lazan,

### TUESDAY (*Continued*)

**9:30 a.m.**

Sontag Scientific Corporation, Greenwich, Conn., S. W. Herwald, Westinghouse Electric Corporation, E. Pittsburgh, Pa., and R. W. Gemmell, manager, aviation engineering section, Westinghouse Electric Corporation, E. Pittsburgh, Pa.*

Precision Speed Measurements for Wind Tunnels, by R. K. Fairly and H. L. Clark*

Electromagnetic Torque Meter, by D. F. Livermore and M. W. Hively*

Uniform Symbolism for Regulatory Controls, by G. A. Philbrick

**12:15 p.m.**

Management Luncheon: *Speaker:* K. T. Keller, president, Chrysler Corporation, Detroit, Mich.

Fuels Luncheon: *Speaker:* Harold J. Rose, vice-president and director of research, Bituminous Coal Research, Inc., Pittsburgh, Pa.

**2:30 p.m.**

#### Rubber and Plastics (II)

*Jointly with Rubber and Plastics Division of the Metropolitan Section, A.S.M.E.*

Foam Sponge, by W. L. Jantzen, U. S. Rubber Company, New York, N. Y.

Creep of Neoprene in Shear Under Static Conditions, by W. Newlin Keen, E. I. du Pont de Nemours and Co., Wilmington, Del.*

A Vibration Investigation, by Lloyd Muller, Buick Motor Division, General Motors Corp., Flint, Mich.*

Advances in Rubber During 1945, by Ernest Chilton, Firestone Tire and Rubber Company, Akron, Ohio

#### Management (III)

Management's Responsibility for the Structure of Compensation

Problems Encountered by Management and Labor in the Installation of Job Evaluation and Merit Rating, by Asa S. Knowles, dean, School of Business Administration, Rhode Island State College, Kingston, R. I.

Sound Application of Weight Incentives in a Peacetime Economy, by James Keith Louden, production manager, glass & closure division, Armstrong Cork Co., Lancaster, Pa.

Management's Problem of a Guaranteed Annual Wage, by Carl E. Gill, director of industrial relations, Warnskuck Co., Providence, R. I.

#### Applied Mechanics (IV)

A Uniform Method for Determining Angular Acceleration in Mechanisms, by L. R. Koenig, Washington University, St. Louis, Mo.

The Calculation of the Multiple-Span Critical Speeds of Flexible Shafts by Means of Punched-Card Machines, by A. W. Rankin, turbine-generator engineering division, rotor and diaphragm section, General Electric Co., Schenectady, N. Y.*

Equivalent Circuits for the Numerical Solution of the Critical Speeds of Flexible Shafts, by Gabriel Kron, consulting engineer, General Electric Company, Schenectady, N. Y.

Energy Losses in Chain-Belt Problem, by F. R. Archibald, Providence, R. I.*

A Graphic Resolution of Strain, by N. J. Hoff, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. (To be read by title)

A Graphical Method for the Evaluation of Principal Strains From Normal Strains, by G. Murphy, Iowa State College, Ames, Iowa. (To be read by title)

#### Hydraulic (I)

Effect of Viscosity on Centrifugal-Pump Performance, by Arthur T. Ippen

Rotary Pump Theory, by Warren E. Wilson

#### Wood Industries (II)

Recent Developments in Wood Finishes, by Paul Kennedy, Murphy Finishes Corporation, Newark, N. J.*

Glued Laminated Arches With Sawn Laminations, by Lieut. Comdr. Eugene A. Dubin, U. S. Coast Guard, Washington, D. C.*

Recent Developments in Kiln-Drying, by John B. Welch, Standard Dry Kiln Co., Indianapolis, Ind.

#### Power (III)

A Comparison of Operation of Forced- and Natural-Circulation Boilers, by George F. Ross, Koppers Company, Inc., butadiene division, Kobuta, Pa., and Leonard Wilkins, Koppers Company, Inc., butadiene division, Kobuta, Pa.

Effect of Flow Conditions in Large Ducts on the Performance of Inertia Cinder Catchers, by E. W. Bullock, Fly Ash Arrestor Corporation, Birmingham, Ala., and W. B. White, Consolidated Edison Company of New York, Inc., New York, N. Y.

Compression Distillation, by Allen Latham, Jr., Arthur D. Little, Inc., Cambridge, Mass.*

The Control of Fouling Organisms in Fresh- and Salt-Water Circuits, by John G. Dobson, Wallace & Tiernan Products, Inc., Belleville, N. J.

#### Education and Training (II)

Exporting Industrial Technology, by H. B. McCoy, chief, Division of Industrial Economy, Bureau of Foreign and Domestic Commerce, Washington, D. C.

Blueprint for Postwar American Know-How, by Elliott S. Hanson, president, International Training Administration, Inc., Washington, D. C.

Training of China's Technicians in China and America, by Paul B. Eaton, Lafayette College, Easton, Pa.

Discussion Leader: Leonard J. Fletcher, Mem. A.S.M.E., director of training, Caterpillar Tractor Co., Peoria, Ill.

**6:00 p.m.**

#### Applied Mechanics Dinner

*Speaker:* Dr. C. C. Furnas, Curtiss-Wright Corporation

*Subject:* Future Trends in Aviation

#### Industrial Instruments and Regulators Dinner

#### Wood Industries Dinner—25th Anniversary

*Toastmaster:* P. H. Bilhuber, vice-president and director, Steinway Piano Co., New York, N. Y.

*Symposium:* Wood and Its Utilization in the Future

The Outlook for Woodworking Machinery, by C. L. Babcock of the Babcock Machinery Corporation, Newark, N. J.

The Outlook for Wood Finishes, by Paul Kennedy of the Murphy Finishes Corporation, Newark, N. J.

The Outlook of Adhesives, by T. D. Perry, Resinous Products and Chemical Co., Philadelphia, Pa.

The Outlook for Wood Furniture, by C. B. Lundstrom, Standard Furniture Co., Herkimer, N. Y.

Better Uses of Forest Materials, by F. J. Hanrahan, American Lumber Manufacturers Association, Washington, D. C.

Production Incentives in the Wood Industries, by John Willard, Bigelow, Kent, Willard and Co., Boston, Mass.

**8:15 p.m.**

#### Marine Power Meeting

*Sponsored by Metropolitan Section, A.S.M.E.*

Speaker: Hubert Scott-Paine, British engineer and industrialist, Marine Designing and Engineering Development Corporation, Greenwich, Conn.

Origin and Development of PT Boat and High-Speed Deep-Sea Air or Sea Rescue Vessels

#### Hydraulic (II)

Hydraulic Gate Equipment for Recent Projects of the Tennessee Valley Authority, by Kenneth C. Roberts

Coaster Gate and Handling Equipment for River Outlet Conduit at Shasta Dam, by Jacob E. Warnock and Howard J. Pound

#### Power (IV)—Fuels (III)

Symposium on Reducing Losses in Power Generation and Consumption

### TUESDAY (*Continued*)

**8:15 p.m.**

*Speakers:* H. D. Harkins, E. I. du Pont de Nemours & Company, Wilmington, Del.; Frank L. Bradley, Forstmann Woolen Company, Passaic, N. J.; O. F. Campbell, Sinclair Refining Company, East Chicago, Ind.; J. R. Michel, Commonwealth Edison Company, Chicago, Ill.; D. C. Weeks, Consolidated Edison Company of New York, Inc., New York, N. Y.

#### Consulting Engineering

Information in final program

#### Management (IV)

Distribution and the Engineer, by Fenton B. Turck, Turck, Hill and Co., New York, N. Y.

#### Heat Transfer (II)

Logographs, by R. S. Tour, University of Cincinnati, Cincinnati, Ohio

Temperature Uniformity in Heating-Up Processes, by M. P. Heisler, Columbia University, New York, N. Y.

#### Wood Industries (III)

Recent Developments in Synthetic Resins and Their Relations to Wood Products, by H. E. Smith, Centro Research Laboratories, Inc., Brooklyn, N. Y.

Ingenious Methods of Furniture Manufacture, by Roger Smith, L. B. Ramsdell Company, Gardner, Mass.

Boat Manufacturing on the Assembly Line, by Richard Owens, Owens Yacht Co., Baltimore, Md.

#### Production Engineering (II)

Improved Milling System to Decrease Cutter Inventories and Costs, by A. A. Schwartz, Bell Aircraft Corp., Buffalo, N. Y.

### WEDNESDAY, NOVEMBER 28

**9:30 a.m.**

#### Management (V)

Management Research and the Engineer

#### Process Industries

Design and Operating Characteristics of the "ter Meer Continuous Centrifugal," by H. F. Irving, Baker Perkins, Inc., Saginaw, Mich.

Air-Gas Ratio Control by Single Impulse Pressures, by H. O. McRae, North American Mfg. Co., Cleveland, Ohio

#### Oil & Gas Power (II)—Aviation (IV)

Aircraft Gas Turbine for Propeller Drive, by Alan Howard and C. J. Walker, General Electric Co., Schenectady, N. Y.

Jet Propulsion Engines, by R. P. Kroon, Westinghouse Electric Corp., Lester, Pa.

### WEDNESDAY (*Continued*)

**9:30 a.m.**

#### Applied Mechanics (V)—Aviation (V) Biomechanics (I)

An Approach to the Study of the Tensile Properties of Fibrous Tissue, by P. R. Marvin, Milwaukee Gas Specialty Co., Milwaukee, Wis.

A Study of Screws for Metal Bone Plates, by A. H. Stang, senior materials engineer, National Bureau of Standards, Washington, D. C.

Pressures in Bone Joints, by E. O. Waters, Yale University, New Haven, Conn.

Mechanical Principles Involved in Reconstructive Operative Surgery, by P. D. Wilson, Ruptured and Cripples Hospital, New York, N. Y.

**12:15 p.m.**

General Luncheon: *Speaker:* Vannevar Bush, director, Office of Scientific Research and Development, Office for Emergency Management, Washington, D. C.

**2:30 p.m.**

#### National Research Program

Research Developments for the A. A. F., by Major Gen. B. W. Chidlaw, Deputy Commander T-3 Engineering, Wright Field, Dayton, Ohio

Research Development Requirements for the Navy, by Rear Admiral Harold G. Bowen, U.S.N., Naval Research Laboratory, Anacostia Station, Washington, D. C.

Paper by Dr. William F. Durand, former Chairman, Division of Engineering and Industrial Research, National Research Council, Washington, D. C.

#### Railroad (I)—Fuels (IV)

Symposium

Utilization of Solid Fuels in Railroad Motive Power

Future Developments in the Use of Coal in Railway Motive Power, by K. A. Browne, research consultant, Chesapeake & Ohio Railway Company

Locomotive Fuel From the Coal Man's Viewpoint, by C. F. Hardy, chief engineer, Appalachian Coals, Inc., Cincinnati, Ohio

Utilization of Coal in the Locomotive, by A. A. Raymond, superintendent, fuel and locomotive performance, N.Y.C.-R.R., Buffalo, N. Y.

Air Supply to Locomotives, by R. A. Sherman, supervisor, fuels division, Battelle Memorial Institute, Columbus, Ohio

**6:00 p.m.**

#### Annual Banquet

*Toastmaster:* Alex D. Bailey, President, A.S.M.E.

*Speaker:* Victory Through Air Power, by Lieutenant General Ira C. Eaker, United States Army, Deputy Commander, Army Air Forces, Washington, D. C.

### THURSDAY, NOVEMBER 29

**9:30 a.m.**

#### Applied Mechanics (VI)—Power (V)

Sliding Friction Under Extreme Pressures, by S. J. Dokos, South Philadelphia Works, Westinghouse Electric Corporation, Philadelphia, Pa.

The Influence of Film Journal Bearings on the Stability of Rotating Machines, by A. C. Hagg, Westinghouse Electric Corporation, E. Pittsburgh, Pa.

Properties of Steam at High Temperatures, by John I. Yellott, director of research, Locomotive Development Committee, Baltimore, Md.; Eric Lype, senior mechanical engineer, Institute of Gas Technology, Chicago, Ill., and Morris Friedman, chemical engineer, Institute of Gas Technology, Chicago, Ill.

#### Materials Handling (I)

*Ordnance Supply System*

Army Ordnance Depot Problem

Scheduling Depot Operations, by Brig. Gen. E. E. MacMorland, U.S.A., chief, Field Service, Office of Chief of Ordnance, Washington, D. C.

#### Railroad (II)

Railroad Motive Power Trends, by Ralph A. Johnson, chief engineer, Baldwin Locomotive Works, Philadelphia, Pa.

Tests of Oil-Film Journal Bearings for Railroad Cars, by S. J. Needs, Kingsbury Machine Works, Inc., Philadelphia, Pa. (presented by title)*

#### Petroleum (I)

Materials of Construction in the Petroleum Industry, by T. McLean Jasper, General American Transportation Corporation, Chicago, Ill.

Mechanical Properties of 8–10 Per Cent Nickel Steel for Use at Subzero Temperatures, by B. B. Morton, International Nickel Co., New York, N. Y., and M. J. Conway, Lukens Steel Co., Coatesville, Pa.

#### Oil & Gas Power (III)—Power (VI)

Details of Gas-Turbine Design, by R. A. Riester and F. O. Hennig, Elliott Co., Jeannette, Pa.

The Elliott-Lysholm Compressors, by W. A. Wilson and J. W. Crocker, Elliott Co., Jeannette, Pa.

#### Textiles (I)

Information in final program

**12:15 p.m.**

#### Railroad Luncheon

### THURSDAY (*Continued*)

**12:15 p.m.**

**Materials Handling Luncheon**

*Speaker:* R. M. Gates, founder of Division, president, Air Preheater Corporation, New York, N. Y.

**Petroleum Luncheon**

**2:30 p.m.**

**Applied Mechanics (VII)—Aviation (VI) Biomechanics (II)**

The Mechanics of Human Muscles, by H. W. Haggard, laboratory of applied physiology, Yale University, New Haven, Conn.

Limits of Factors of Safety in the Human Body, by E. F. DuBois, Cornell University Medical College, New York, N. Y.

Application of Biomechanics to Airplanes, by F. Teichmann, New York University, New York, N. Y.

Principles Involved in Prosthetic Devices, by Paul E. Klopsteg, The Technological Institute, Northwestern University, Evanston, Ill.

**Oil & Gas Power (IV)—Power (VII)**

The Elbow Combustion Chamber, by M. A. Mayers and Wayne W. Carter, Elliott Co., Jeannette, Pa.

The Escher Wyss AK Closed-Cycle Turbine, Its Actual Development and Future Prospects, by Curt Keller, director of research, Escher Wyss, Zurich, Switzerland

**Railroad (III)**

Railroad Passenger Cars—1946 Models, by Allen W. Clarke, assistant general mechanical engineer, American Car & Foundry Co., St. Charles, Mo.

**Materials Handling (II)**

*Ordnance Supply System*

Ordnance Storage Techniques

Ordnance Saves Money, by Brig. Gen. E. E. MacMorland, U.S.A., chief, Field Service, Office of Chief of Ordnance, Washington, D. C.*

**Petroleum (II)**

Lubricants as Engineering Materials, by by C. L. Pope, Eastman Kodak Co., Rochester, N. Y.

Mechanical Seal Failures and Their Causes, by Douglas R. Lewis, Mech. Engr., Newark, N. J.

**Metal Cutting (I)**

The Cutting Action of Reamers, by T. F. Githens, mechanical engineer, Cleveland Twist Drill Co., Cleveland, Ohio

Recent Developments in the Field of Crush Dressing of Grinding Wheels, by R. Y. Moss, production engineering manager, The Sheffield Corp., Dayton, Ohio

Management Control of Industrial Accidents, by Clifford E. Paige, president, Brooklyn Union Gas Co., Brooklyn, N. Y.

### THURSDAY (*Continued*)

**2:30 p.m.**

**Management (VI)—Safety**

Postwar Plans for Safety Standardization, by Cyril Ainsworth, assistant secretary, American Standards Association, New York, N. Y.

Placement Program for Physically Impaired Workers, by John Grimaldi, research engineer, National Conservation Bureau, New York, N. Y.

**Textiles (II)**

Information in final program

**6:00 p.m.**

**Aviation Dinner**

*Subject:* Future of Private Flying

*Toastmaster:* Capt. Luis de Florez

Future of Private Flying, by W. A. M. Burden, Assistant Secretary of Commerce, Washington, D. C.

Future of Private Flying From the Users' Standpoint, by Arthur I. Boreman, Des Moines, Iowa

*Film:* Flivver Flying

**Petroleum Dinner**

*Sponsored by Petroleum Committee and Hydraulic Division*

Speaker and subject to be announced in final program

**8:15 p.m.**

**Power (VIII)**

*Marine Symposium*

Automatic Control of Marine Power Equipment

There has been a great increase in the number of recent ships equipped with automatic control of combustion, boiler water level, pump speed, and related functions. Representatives of several manufacturers will discuss various angles of this comparatively new development in marine practice.

**Materials Handling (III)—Management (VII)**

Information in final program

**Metal Cutting (II)**

The Face Milling of Cast Iron and Ferrous Alloys, by O. W. Boston and W. W. Gilbert, department of metal processing, University of Michigan, Ann Arbor, Mich.

Specific Studies Pertaining to Tool Wear, Chip Characteristics, and Surface Finish of Free Cutting Steels, by G. P. Witteman, assistant metallurgical engineer, Bethlehem Steel Company, Bethlehem, Pa.

**Railroad (IV)—Applied Mechanics (VIII)**

Design and Application of Rail Transportation Gearing, by D. R. Meier and J. C. Rhoads, transportation motor engineering division, General Electric Co., Erie, Pa.*

### THURSDAY (*Continued*)

**8:15 p.m.**

Design of Crankpins for Locomotives, by O. J. Horger, The Timken Roller Bearing Co., Canton, Ohio, and W. I. Cantley, Association of American Railroads, Chicago, Ill.*

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*Important*

## Hotel Reservations

HOTEL conditions in New York City are difficult at present, but we are advised that during the week of our meeting they should be greatly improved. Members are urged to write promptly to Hotel Pennsylvania or to the hotel of their choice at once, requesting confirmed reservations. If the Hotel Pennsylvania is selected, be sure to mention attendance at the A.S.M.E. Annual Meeting.

## Member's Rendezvous

PROVISION has been made for the foyer to the Keystone Room, located on the Mezzanine of the Ballroom floor of the Hotel Pennsylvania, as a rendezvous for members. There will be comfortable chairs available there.

## Meal Reservations

ALTHOUGH food conditions are greatly improved, members in attendance at the Annual Meeting will make it much easier by making known in advance the meals for which they will wish tickets. A complete detail of these meals and a form coupon for making reservations will be provided in the announcement which will be mailed to all members. Because of these advanced reservations, members are warned of the possibility of their being disappointed if they wait until coming to the meeting to obtain these tickets. In 1944 the banquet tickets were sold out three weeks in advance of the meeting. Obviously there is a limited capacity of all rooms where these meal meetings are scheduled to be held.

## Women's Program

The A.S.M.E. Woman's Auxiliary will provide a program of events and entertainment for all women attending the Annual Meeting. The program will be similar to that offered at the 1944 Annual Meeting.

# President's Page

## *Another Year Ends*

ANOTHER year of Society activity is drawing to a close, a year which has been unusual in many respects and one which has presented many interesting and difficult problems. It has been a year of progress, nevertheless, and individually and as a Society we have reason to view our accomplishments with considerable satisfaction.

Travel restrictions made it impossible to maintain the contacts between Officers of the Society and the Sections which were common in the past, but with the new organization plan which provides Regional Vice-Presidents, a closer bond will be established between the individual member, the Sections, and the Officers of the Society, which should effect better co-operation and co-ordination of the Society's various activities and a better understanding of its operation.

Although it was necessary to cancel the Spring Meeting, scheduled for Boston, the Semi-Annual Meeting in Chicago, which took on the aspects of a Section meeting, was well attended and very successful. The meetings and the papers presented would be a credit to any national meeting. The Fall Meeting in Cincinnati was very successful in spite of the fact that the ban on travel was lifted only a few days before the meeting. The Annual Meeting in New York City will be held as usual.

Our Society can be proud of its record of service to our country during the war period. Several of our members occupied positions of national importance and thousands were in positions of greater or lesser importance in industry and in civilian branches of government service. The three thousand members in the Armed Forces certainly did their share regardless of their position. We are looking forward to their early return to civilian life and hope that we can assist them in establishing themselves in their respective communities.

The record of the year just closing, like those of its predecessors, shows certain accomplishments and positive progress. Each new year presents new problems and new opportunities. The importance of the engineer was emphasized in the entire war activity, and his importance in our national development was definitely established and recognized. Pride in our achievement must be accompanied by determination to make good on our present pressing problems so that the engineering profession may continue to increase in usefulness.

The outgoing Officers and Members of Council salute those who have recently been elected to fill their places. We congratulate the members of the Society on the choice they have made and congratulate the new Officers as we turn over to them a healthy prosperous working organization which has always been a credit to our profession.

(*Signed*) ALEX D. BAILEY, *President*, A.S.M.E.

# A.S.M.E. Fall Meeting at Cincinnati, Oct. 2 and 3, Featured Papers on Metal Cutting

PAPERS on metal cutting bulked large on the program of the Cincinnati Section Fall Meeting of The American Society of Mechanical Engineers, held at the Hotel Netherland Plaza, Cincinnati, Ohio, Oct. 2 and 3, 1945, where an attendance of 225 was registered. Other subjects were discussed at sessions sponsored by the Rubber and Plastics, Management, Applied Mechanics, Metals Engineering, Fuels, Aviation, and Railroad Divisions. In addition to luncheons on both days and a dinner on Tuesday, at which Alex D. Bailey, President of the Society, was the speaker, and a buffet supper on Wednesday, there were three inspection trips and a memorial session to the late Dean Herman Schneider, which was under the auspices of the Committee on Education and Training for the Industries and featured a symposium on co-operative education. Members of the Council of The American Society of Mechanical Engineers also held an informal meeting.

### What Europe Teaches

Those attending the Tuesday luncheon heard an excellent talk by Kenneth H. Donaldson, head of the Department of Metallurgical Engineering, Case School of Applied Science, on Europe as it is today and the lesson America must learn from the war. The lack of preparedness and the time consumed in assembling and equipping our Army and Navy would have made us vulnerable to attack had not England served as an outpost for our shores. The need for constant research and the development of defensive, as well as offensive equipment seems necessary if the United States is to be protected from the same destruction, at some future date, that has taken place in Europe during this war. The views expressed by Mr. Donaldson were based on a postwar visit to Europe and a firsthand study of conditions.

### The Society's Contribution to the War

Alex D. Bailey, President of the Society, in his address at the dinner on Tuesday night, pointed out the large number of members of the Society who had taken an active part in the war effort and the contributions made by the Society as a whole through its various committees. Because of these activities, the Society had been awarded the Distinguished Service Award by the Ordnance Department.

The educational side of the Society was also emphasized by Mr. Bailey. Valuable material has been published or is being prepared in the form of manuals, handbooks, and bibliographies. Letters have gone out to each of the 3000 members of the Society in the Armed Forces and the Society has offered its services in assisting these members to solve their educational problems. A large number of replies have been received, Mr. Bailey said. In many cases, these replies fall into a general pattern and can be answered by form letters. Many cases are of a special nature and call for careful analysis and special letters.

President Bailey expressed the opinion that the Society is charged with a responsibility to the youth of today and his place in the world of tomorrow. The Society can and should do much to promote interest in engineering education.

### Shoults Talks on Future of Aviation

The future of aviation was discussed by D. R. Shoults following the luncheon on Wednesday. He pointed out that whereas a few years ago it was thought that the size of the future plane would be set by its weight, it now seems apparent that pay load will be the controlling factor and that size is of secondary consideration.

The need for aeronautical engineers was emphasized, according to the speaker, by the fact that practically all of the planes used during the war were designed or at least on the drawing board before war broke out. The development of the postwar plane will call for a large group of highly trained engineers supplemented by technical graduates, to fill the gap left by the four years of practically zero formal education.

With speeds approaching that of sound, new factors have entered the field of aviation. Air flow is seriously changed at high speeds, calling for a restudy of plane construction.

In addition to the three dimensions, length, breadth, and height, he pointed out, aviation has added speed. At speeds of 500 miles per hour and higher, the distance at which objects are visible is short as measured in flying time. This factor introduces additional hazards and calls for the development of equipment well in advance of that now in use.

The gas turbine seems to be the answer to short runs at high speed, Mr. Shoults said, but the economy of the reciprocating engine places the standard engine in a favorable position for long flights.

### Visits to Local Plants Add Interest

Relaxation was found in the various inspection trips planned by the local Committee on Plant Visits. The visit to the plant of the Cincinnati Milling Machine Company on Tuesday afternoon aroused most general interest. The plant was thrown open to the Society and the party was broken into small groups so that every one had a chance to see and hear everything that went on.

The popularity of plastics drew a greater number of visitors to the Formica Insulating Company than did the visit to the Columbia Power Station. The Formica Insulating Company covers a wide range in the plasticizing of woods, paper, cloth, glass, and asbestos. Visitors were given an opportunity to study the methods used in each process as well as the molding of plastic parts.

### Memorial Session to Dean Schneider

The Cincinnati meeting was brought to a close Wednesday evening by a Memorial Session in honor of the late Dean Herman Schnieder held at the Engineering Institute.

Clyde W. Park, professor of English at the University of Cincinnati, gave a brief history of Dean Schneider's endeavor to interest industry and educational institutions in and around Cincinnati in co-operative training and the final acceptance of the plan. He pointed out that the proof of its success lay in the careers of a number of the men, now holding prominent positions, who had come up through this form of education.

John T. Faig, fellow A.S.M.E. and president, Ohio Mechanics Institute, pointed out the distinction between the engineering college and the co-operative institute and the confusion between the two frequently caused by the use of the term "institute." A clear distinction was made between the two and the limitations of both were emphasized.

W. W. Tangeman, junior member A.S.M.E. and vice-president, Cincinnati Milling Machine Company, himself a product of co-operative education, told a convincing story about the definite place in industry to be filled by men from this educational group. He expressed the opinion that the broader training of the Engineering College was not needed in many of the important positions in industry, whereas the experience, sense of responsibility, and understanding of personnel problems gained through the industrial side of co-operative education were invaluable in many executive positions.

### Committee in Charge

The Cincinnati Committee in charge of the meeting consisted of M. M. Martellotti, chairman of the A.S.M.E. Cincinnati Section and chairman of the Fall Meeting Committee; Hans Ernst, chairman of technical events; Carl F. W. Frank, chairman of plant visits, transportation, and hotel reservations; E. W. Vinnedge, chairman, entertainment and reception; H. L. Haworth and H. B. Welge, finance committee; and C. A. Mitchell, information, registration, printing, and signs.

## Preprints of 1945 Annual Meeting Papers

AS usual, a considerable number of papers to be presented at the 1945 A.S.M.E. Annual Meeting to be held at the Hotel Pennsylvania New York 18, N. Y., Nov. 26 to Nov. 29, 1945, will be available in preprint form for distribution.

The program of the Meeting which appears on pages 769 to 773 of this issue indicates the papers to be ready (so far as is known at press date) for distribution a week in advance of the Meeting. Many of the other papers will also be made available in pamphlet form but few of them are likely to be ready for distribution in advance of presentation at the sessions.

Charges for preprints ordered by mail range from 15 to 30 cents a copy, depending on the number of pages (10 to 25 cents if purchased at publication booth). However, since it is not possible to state at this time the number of pages in these papers, we suggest that fifteen cents be forwarded for each preprint ordered. If remittance is insufficient, bill will be rendered for the difference.

Every effort will be made to fill orders promptly but delivery in advance of meeting cannot be guaranteed.

Please send order and remittance to A.S.M.E. Headquarters, 29 West 39th St., New York.

# Engineers of United States, United Kingdom, and Canada Hold Conference on Unification of Engineering Standards at Ottawa, Sept. 24 to Oct. 6

THE Conference on the Unification of Engineering Standards, which was held under the auspices of the Combined Production and Resources Board at Ottawa, Canada, Sept. 24–Oct. 6, 1945, brought together many notable engineers of the United States, United Kingdom, and Canada. During the course of the discussions, which included the subjects of screw threads, pipe threads, drawing practice, metrology, and limits and fits, a solid basis for agreement was reached on many aspects of these highly technical problems. It is anticipated that proposals on specifications will be developed on the basis of agreements reached by the delegates through the normal machinery which exists in the various countries for this purpose.

### Screw-Thread Forms

The fundamental differences between British and American screw-thread forms, which caused tremendous production and supply difficulties during the war, were resolved to the point where the delegates were prepared to return to their respective countries with a specification for a basic thread form that would provide a unified standard for all countries employing the "inch" system. This basic form retains the best features of the present forms and at the same time a series of associated diameters and pitches have been worked out which it is believed will simplify existing practice and yet provide an adequate range of choice for all general requirements. It is also felt that the proposed change would involve the minimum amount of departure from existing practice consistent with the obtaining of the object in view—a common standard for general-purpose threads to the inch system of measurement. The proposal on a basic thread form was by far the most outstanding accomplishment of the Conference and exemplifies the spirit of collaboration that prevails among the engineering professions of the three countries.

### Acme and Stub-Acme Threads

Hardly less noteworthy is the agreement reached at the Conference on Acme and Stub-Acme threads. It is this type of thread that is extensively used on aircraft, machine tools, and other mechanical devices where a traverse motion is required. While these specifications will be submitted to industry in the three countries through the national standards bodies, representatives of the three countries attending the Conference feel certain that what they term an A-B-C Standard will be speedily approved.

The delegates to the Conference reached a mutual understanding on specifications for small screws such as are used in watches and clocks. Repair of these items, as many laymen know, has been often complicated due to the lack of unified standards for the small screws used for fastening delicate parts, and this step taken at Ottawa should ultimately prove of great value in the years to come. An understanding was also reached on threads for microscope lenses, and it was decided that steps should be immediately taken to write unified standards for all threaded parts for cameras, including the screw thread for mounting on tripods. Agreement was reached on a specification for fine motion screw threads, such as are employed in micrometers. The greatest spirit of co-operation was shown by the delegates of the three countries, and plans to further resolve differences in specifications for various screws used in optical, electrical, and scientific instruments, are already under way.

### Buttress Thread Form

In what might be termed special thread forms, engineers from the three countries reached an understanding on certain specification aspects of the Buttress thread form. It is this type of thread which is used extensively on airplane propeller hubs and in other applications where stresses are in one direction only. Considerable progress was made in the assembling of engineering data on high-duty studs in light alloys but the diversity of practices, particularly between Great Britain and the United States, made it impossible to formulate definite recommendations for a unified practice. It was the consensus of the engineers present that a great deal of exploratory work was required in this field.

The differences in drawing practices between the countries, particularly in the United Kingdom and the United States, have caused no little difficulty during the war. Discussions between Great Britain and the United States were initiated a year ago, and since that time a considerable exchange of data has taken place. A number of delegates mentioned delays of up to a year spent in redrawing such equipment as bomb sights and Bren and Bofors guns designed in one country and required to be manufactured in another. Reference was again made to the case of the Merlin Rolls-Royce engine in the United States. It will be remembered that it was this excellent engine which powered the British *Hurricanes* and *Spitfires* that so successfully defended England during the first blitz of the war. The discussions on drawing practice held during the conference were what was termed "exploratory" in character. Considerable data were exchanged between engineers of the three countries and it was unanimously recommended that the subject should be pursued actively with a view toward unification of practice.

### Pipe Threads

The meeting held on pipe threads, while not conclusive in its findings, resulted in an invitation to British and Canadian representatives to continue discussions at the convention of the American Petroleum Institute in November. It is understood that this invitation will also be extended to valve and fitting manufacturers and others interested in this subject.

In somewhat the same category was the subject of limits and fits in engineering. While this subject has been studied in the three countries over a period of the last two years, only partial agreement was obtained due to the highly technical aspects of the problem coupled with the rather diversified practice to which each country is committed. It was decided, however, that further discussions toward reaching a more complete agreement were desirable and a meeting on this subject has been scheduled to take place in New York, N. Y., prior to the return of the British delegation.

Practices in precision measurement and gaging methods were included as a separate item on the agenda for the first time. Outlines of progress made in precision measurement were presented at the sessions held on this subject and suggestions were made which, it is hoped, will ultimately lead to the co-ordination of practices in the three countries. Data were also offered which outline proposed specifications for screw threads and connection details for gas cylinders.

The British delegation, numbering fifteen, plan to visit various industrial centers in Canada and the United States and are expected to leave for England sometime during the latter part of October.

## 1946 Officers of A.S.M.E. Elected by Letter Ballot

AS reported by the tellers of election Paul Diserens, Robert L. Sackett, and Harvey E. Molé, letter ballots received from members of The American Society of Mechanical Engineers were counted on Tuesday, Sept. 25, 1945. The total number of ballots cast was 5549; of these 5 were thrown out as defective.

| *Candidates* | *Votes for* | *Votes against* |
|---|---|---|
| *For President* | | |
| D. ROBERT YARNALL | 5530 | 14 |
| *For Regional Vice-Presidents* | | |
| To serve 2 years | | |
| ALEXANDER R. STEVENSON, JR. | 5527 | 17 |
| SAMUEL R. BEITLER | 5521 | 23 |
| J. CALVIN BROWN | 5523 | 21 |
| To serve 1 year | | |
| RUDOLPH F. GAGG | 5525 | 19 |
| EDWARD E. WILLIAMS | 5527 | 17 |
| LINN HELANDER | 5526 | 18 |
| *For Directors-at-Large* | | |
| EDGAR J. KATES | 5532 | 12 |
| J. NOBLE LANDIS | 5536 | 8 |
| Miscellaneous | 31 | .. |

The new officers will be introduced and installed in office during the Sixty-Sixth Annual Meeting of the Society to be held at the Hotel Pennsylvania, in New York, N. Y., Nov. 26 to Nov. 29, 1945.

Biographical sketches of the newly elected officers were published in the August, 1945, issue of MECHANICAL ENGINEERING, pages 551–559.

# Local Sections

## The Atomic Bomb Subject at Baltimore Section

On Sept. 24 a meeting was held at the Engineer's Club of Baltimore, Baltimore, Md., when a total of 250 members and guests attended. The program consisted of a talk by Dr. R. D. Fowler on "The Atomic Bomb." Dr. Fowler outlined the scientific background of the bomb, reviewing the steps from the discovery of fission to its employment in the bomb. He said, in the course of his lecture, that the bomb could not long remain a secret, as many nations were very close to developing such a weapon, but were forced to stop their research because of lack of resources.

## Dr. Willibald Trinks Speaks at Bridgeport Section

The first meeting of the new season was held on Sept. 27 at the Hotel Barnum, Bridgeport, Conn. After the dinner, Dr. Willibald Trinks, member A.S.M.E., professor emeritus of mechanical engineering of the Carnegie Institute of Technology, Pittsburgh, Pa., gave a talk on modern research methods in the production and development of steel. The lecture was illustrated. Dr. Trinks has spent many years on steel research and holds chairmanships or memberships on numerous A.S.M.E. research committees, some of which have done vital government war work, and his lecture was of great interest to the audience.

## Cincinnati Section Starts New Season With Ladies' Night

With its annual ladies' night dinner meeting, the Section opened its 1945–1946 program on Sept. 6, at the Herman Schneider Memorial Building, Cincinnati, Ohio. Through the courtesy of the Fouke Fur Company, St. Louis, Mo., F. W. Trampe gave a talk on "Romance of Alaska Sealskin," illustrated with a film in color. Mr. Trampe's twenty years' association with the Fouke Fur Company has taken him from Seattle to the Pribilof Islands in the Bering Sea, 300 miles north of Dutch Harbor in the Aleutians, and his experiences have qualified him as an authority in the seal industry. He sketched for the audience the fascinating life cycle of seals, and the inside story of the sealskin industry. The pictures were of particular scenic and war interest, many of them showing areas successfully defended against the Japs. Fifty-five members, their wives, and guests attended the dinner.

## Dayton Section Is Guest of American Rolling Mill Company

On Sept. 18 the Section members were guests of the American Rolling Mill Company, Middletown, Ohio. After dinner at the Manchester Hotel, they were conducted on a specially arranged trip through the East Works of the Company. Fifty-five members and guests made the trip.

## The Postwar World Discussed at Kansas City Section

At the Sept. 14 meeting, the first of the season, held at the University Club, Kansas City, Mo., the speaker was Captain A. A. Nichoson of the Texas Company. In his talk entitled "Engineering the Blueprint of the Postwar World," Captain Nichoson pointed out that this country was going through a cycle made up of five parts. He said that we have completed four of the parts and are now entering the fifth. First there was a period of investment; second, a period of development; third, a period of production; and fourth, a period of salesmanship, which period has just ended. The fifth and last, he explained, is the period of human relations on which we are just starting. Social security, old-age pensions, unemployment insurance, and retirement benefits, are all part of this last period. He said that we will take the lead in human relations, and that engineering plays a great part in this leadership since through engineering we can produce better things, at less cost, more abundantly and faster than any other nation, and this automatically raises the standard of living and makes a better world. Fifty-one members and several visitors enjoyed both the talk and the lively discussion period which followed.

## Louisville Section Meets With Student Branch

A joint meeting was held on Sept. 20 at the Parkmoor Recreation Center, Louisville, Ky., with the University of Louisville Student Branch. As a large number of the student members were Navy V-12 students, studying gas turbines, the program was planned for their interest and consisted of films on steam and gas turbines by Allis-Chalmers Company, entitled "Tornado in a Box." A social hour followed the program.

## Nuclear Physics Talk at Mid-Continent Section

"The Application of Nuclear Physics" was discussed at the Sept. 27 meeting in the Engineering Laboratories, Tulsa, Okla., by Mr. Fearon. He discussed the application of nuclear physics to engineering development, as well as the background leading up to the atomic bomb. The talk was illustrated with slides.

## Otto de Lorenzi Speaks at New Haven Section

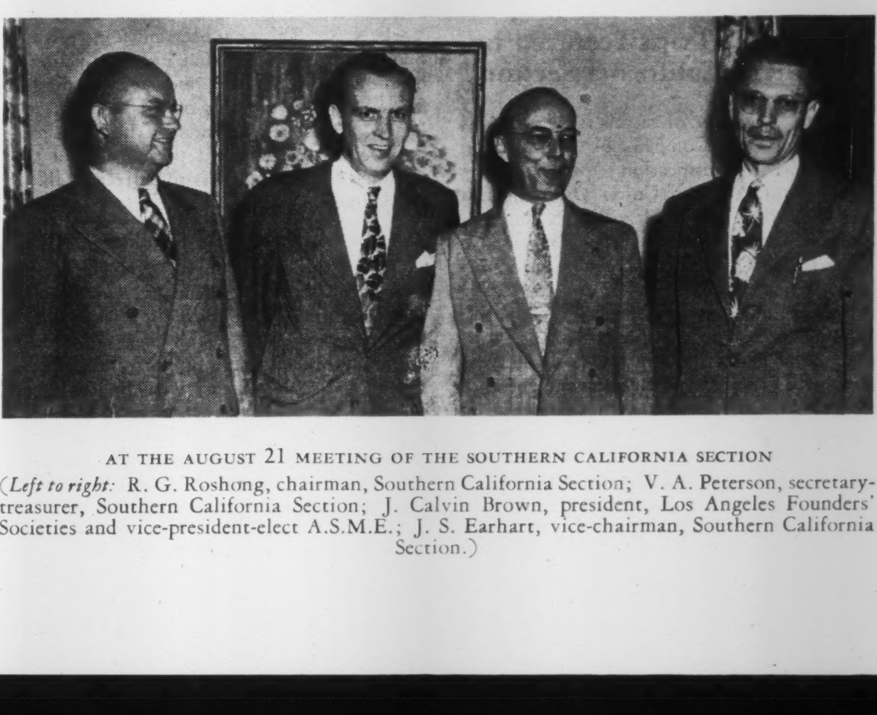
At a dinner meeting on Oct. 10 at Ceriani's Cafe Mellone, New Haven, Conn., the speaker was Otto de Lorenzi, member A.S.M.E., of the Combustion Engineering Company, who gave a talk on "Combustion in the Furnaces of Steam-Generating Equipment." Color films, product of much specialized research, showing the action of firing equipment and the combustion of fuel in the furnace, both on stokers and with pulverized coal, illustrated the talk. The films were made by Mr. de Lorenzi, who is an enthusiastic photographer and took up the work as a hobby. It proved so valuable a method of investigating furnace phenomena that his company has taken up the work of photographing on a large scale. Following the showing of the films, a discussion and question period was conducted by Mr. de Lorenzi and Prof. Walter J. Wohlenberg, fellow A.S.M.E., of Yale University.

## North Texas Section Hears Talk on Its State

Boyce House was the speaker at the nontechnical dinner meeting held at the Stonleigh Hotel, Dallas, Texas, on Sept. 18. His talk entitled "I Give You Texas," was enjoyed by the 26 members and guests present.

## Rock River Valley Section Opens New Season

The season was opened with a dinner meeting on Sept. 21 at the Hotel Hilton, Beloit, Wis. C. J. Sertl of the General Electric Com-



AT THE AUGUST 21 MEETING OF THE SOUTHERN CALIFORNIA SECTION

(*Left to right:* R. G. Roshong, chairman, Southern California Section; V. A. Peterson, secretary-treasurer, Southern California Section; J. Calvin Brown, president, Los Angeles Founders' Societies and vice-president-elect A.S.M.E.; J. S. Earhart, vice-chairman, Southern California Section.)

pany, Schenectady, N. Y., spoke on "Postwar Manufacturing and Tool Engineers." He described the Schenectady plant of his company and told of some of the manufacturing problems during the war, especially on jet propulsion engines, and stressed the need for better standards on engineering drawings. A discussion followed the talk.

## St. Joseph Valley Section Hears Talk on Helical Gears

On Sept. 14 a meeting was held at the Engineers' Club, La Salle Hotel, South Bend, Ind., when John C. Straub, director of research, American Foundry Equipment Company, Mishawaka, Ind., spoke on "Scoring Characteristics of Helical Gears." Mr. Straub, who spent 13 years with General Motors Research, gave an interesting and instructive presentation of the subject. He is co-author with J. O. Almen, head of the mechanical-engineering department of General Motors Research, of papers on automobile transmission gears, and aircraft gearing.

## St. Louis Section Guests of Anheuser-Busch, Inc.

Members and visitors attending the meeting on Sept. 28 were guests of Dr. Adelbert Von Gontart, vice-president and chief engineer, Anheuser-Busch, Inc., St. Louis, Mo., and James Graham Rosborough, acting chief engineer of that company. The meeting-place was the bottling-plant reception-room of Anheuser-Busch, Inc. One hundred and two members and 57 guests were present.

Speakers were David Larkin, vice-president A.S.M.E., redesignated as Director-at-Large for the coming year, and Paul H. Buxton, chairman of the Section, who welcomed and introduced new members of the Executive Committee for the coming season and thanked the retiring members of that committee for their many accomplishments during the past year.

An honored guest was Thomas S. McEwan, manager A.S.M.E., redesignated as Regional Vice-President for the coming year, who gave a brief talk.

## Inspection Trips Featured by Southern California Section

A limited number of members were guests of the Union Oil Company of California on Aug. 25, when an inspection trip, arranged by L. V. Horne, of the Union Oil Co., Los Angeles, Calif., was made through the Wilmington, Calif., refinery. Mr. Miners, also of the Union Oil Company, gave a brief outline of refinery practice before the trip. The large TCC unit in the refinery was of outstanding interest to the guests.

A similar inspection trip was made on Aug. 31, when a group of 35 members were guests of the Standard Oil Company of California, at the El Segundo Refinery, El Segundo, Calif. An excellent lunch was served by the company in the new cafeteria building, following which an interesting visit was made to the Houdry catalytic cracking plant and new machine shops.

MEMBERS OF SOUTHERN CALIFORNIA SECTION A.S.M.E., AT DINNER MEETING, AUG. 21, PASADENA ATHLETIC CLUB, PASADENA, CALIF.

## Syracuse Section Shares in Memorial to Edward N. Trump

A check for $100 to be used to purchase books as a memorial for Edward N. Trump, Syracuse, N. Y., engineer, was presented recently to the Syracuse public library by representatives of the Syracuse Section and the Technology Club of Syracuse. The presentation was made by G. I. Vincent, first vice-president of the Technology Club and Chairman of the Syracuse Section, and D. W. Diefendorf, president of the Technology Club, to Miss Edith P. Schroeder, head of the industrial and business department of the public library. The check will be used to purchase engineering handbooks as a memorial to Mr. Trump, who died June 21, 1944, after more than 60 years of active engineering. Mr. Trump, who was an honorary member of the A.S.M.E., and a charter member of the Technology Club, was recognized as one of America's foremost engineers. He became an A.S.M.E. member the year of its founding and was at one time vice-president. He represented the A.S.M.E. in 1929 at the world engineering conference in Tokyo.

## West Virginia Section Plans for Successful Season

Dr. Lillian M. Gilbreth, member A.S.M.E., professor of management, Purdue University, spoke on "The Engineer in Postwar Management," at the meeting on November 5 held in the Daniel Boone Hotel, Charleston, W. Va. Dr. Gilbreth's lecture was particularly appropriate as this part of West Virginia is a center of chemical industry.

The section is primed for a big year. Following the first "Get Acquainted Meeting," seven meetings are planned, selected by choice of membership as expressed in a questionnaire. The senior members have organized a "Senators' Committee," the principal purpose of which is to secure new members; the "senators" are actively engaged in cultivating this field now, but it is too early to look for results.

## Process Industries Division of Metropolitan Section to Meet on Nov. 8

ONE of the more important meetings of the current season is scheduled to get under way on November 8 at the Engineering Societies Building at 29 West 39th Street, New York, N. Y. There has been much interest displayed in the progress that has been achieved by the manufactured-gas industries in the last few years. As a result of this concern, the Process Industries Division of the Metropolitan Section has solicited the services of two outstanding gas engineers to deliver a talk on this subject.

### A. B. Huyck, Speaker

One of these men is A. B. Huyck of the Brooklyn Union Gas Company. Incidentally this concern has embarked on a large expansion program costing well over six million dollars in order to keep up with increased demands and to be abreast with improvements made in the field. As engineer in charge of manufacture, Mr. Huyck is and has been one of the keymen in this project and knows of all the complications which had to be dealt with and solved. Perplexing problems, such as choice of equipment and process, new plants versus extension of old plants, etc., had to be considered. In his talk he will cover some of the modern developments which resulted from this expansion.

### R. E. Schneiter, Speaker

R. E. Schneiter, assistant engineer, process-engineering department of the Consolidated Edison Company of New York, has consented to be the second speaker. He plans to talk on a topic of special interest, namely the use of liquid propane as an aid to the handling of peak gas loads. At present the largest liquid-propane holders are being constructed in New York and naturally their erection involves considerable engineering. It can be seen that the work being done now can well be a pattern for gas companies to follow the country over.

Acting as chairman of the meeting will be J. B. Boniface of the Public Service Electric and Gas Co. Mr. Boniface is well known throughout the gas industry and in addition to acting as chairman will be able to lend many interesting comments of his own.

The meeting is scheduled to be held in Room 502 at the Engineering Societies Building at 7:30 p.m. It will be in charge of C. H. Carman, Jr., of the Elliott Company, New York, N. Y.

# Student Branches

### California Institute of Technology Branch

At the Aug. 23 meeting, held on the campus, Mr. Peterson, engineer, Elliott Company, Los Angeles, Calif., gave a talk on steam turbines. Mr. Peterson explained the difference between impulse and reaction types of turbines and showed why the impulse turbine is used principally in industry. He explained features of manufacturing specifications, designation of frame size, packing types, and also showed how to start and stop a turbine.

### University of California Branch

New officers for the coming term were introduced at the Aug. 3 meeting held in 105 Engineering. These were: Carl J. Siebly, chairman; Albert Hemenover, vice-chairman; Alexander S. Semenenko, secretary; and Stanley W. Potts, treasurer. A tentative program was outlined, including a dance, picnic, and tour of inspection. A film entitled "World Workshop" was shown, through the courtesy of the General Electric Company.

### Carnegie Institute of Technology Branch

Officers elected for the new term at the Sept. 12 meeting at Machinery Hall were: Andrew J. Pepper, president; William I. Scherb, vice-president; Manuel Goldstein, secretary; Harold A. Gottesman, treasurer. Prof. David C. Saylor continues as honorary president.

The first meeting of the fall term was held on October 2. Programs for future meetings were discussed, and members were unanimously in favor of tours of inspection to factories in the Pittsburgh area.

### Columbia University Branch

The showing of two films loaned by Jenkins Brothers, Bridgeport, Conn., was the feature of the Sept. 6 meeting at the Engineering Building. The first film, "Fluid Highway Control," dealt with the proper use and location of valves. The second film, "A Fair Offer," showed the design and manufacturing steps in making valves.

### Illinois Institute of Technology

At the regular meeting on Sept. 14, the chairman, Morton N. Spector, announced plans for a field trip to some plant engaged in fabrication and manufacturing work. An interesting film "Aluminum and Magnesium Sand Casting—Foundry Practices and Procedures" was shown. This was an Ebaloy technicolor film.

### University of Michigan Branch

At the meeting on Sept. 12 in the Rackham Building, J. B. Thomas explained the use of International Business Machines in handling the paper work of large corporations. Many of the machines were demonstrated, including those which are used in classification and tabulation of jobs, wage rates, and costs.

### New Mexico State College Branch

A short meeting was held on Sept. 6 in Goddard Hall, to discuss plans for a smoker to be given for freshmen later in the month. A committee was appointed to make arrangements.

### Northeastern University Branch

A regular meeting was held on Oct. 4, with 26 members attending. Chairman Paul Heffron introduced the speaker, George Streechon, who is a member of the student body. His talk, entitled "I Was Shot Down," gave a brief picture of the training he went through in the Army Air Corps and told of his experiences with the 18th Air Forces in Southern Italy. After completing 37 missions, he was shot down over Polesti, Rumania, while on his 38th mission. He graphically described his experiences in Rumania and his successful return to his base in Southern Italy.

### University of Southern California Branch

The meeting on Sept. 5 at the Engineering Building was formally opened by the president, John Nash. Discussion was held on the A.S.M.E. dance to be held on Sept. 15, and on an all-engineers' smoker to be sponsored. At the Sept. 7 meeting final plans for an informal dance were arranged.

CORNELL UNIVERSITY STUDENT BRANCH OF THE A.S.M.E.

(*First row, left to right:* Frank Price, Franklin J. Lauten, Harry C. Moore, Jr., Francis C. King, George H. Lee, Richard D. Beard, Charles A. Swerdlove, Burton Scheinman, Bernard Baer. *Second row, left to right:* Robert Reese, Sidney G. Rumbold, Owen J. Black, Irwin H. Miller, Robert Schallman, H. Sphrentz, Harold E. Pirson, Jr., James C. Liu, Robert H. Garmezy. *Third row, left to right:* Ben-Ami Lipetz, Albert H. Shanabrook, Harold C. Yost, Richard Turner, David I. Smith, Sewell Shugar, Harold Bloomfield, Ray Chaiken, Saul Levinson. *Fourth row, left to right:* Jerry T. Ball, Earl D. Barkhuff, John H. Rasch, John Leinbach, William B. Furstman, William Norris. *Fifth row, left to right:* Arthur J. VanVleet, C. W. Mortenson, Frank E. Rom, George W. Cullen, John D. Fishbeck, Charles C. Hansen, Keith W. Benson, Jr., Bernard Pomerantz. *Sixth row, left to right:* George W. Dexter, George L. Clegg, Theodore H. VanLangen, Jr., Charles Burgess, Robert A. Bennett, Ed Braun, William B. Richardson.)

GROUP PICTURE AFTER TECHNICAL SESSION, STEVENS INSTITUTE OF TECHNOLOGY, 1945 ANNUAL STUDENT MEETING, GROUP III

### Stevens Institute of Technology Branch

The first meeting of the new term was held on Sept. 14 in Jacobus Hall. William Rowley, president, opened the meeting with the request that all students check their memberships and renew them if necessary. Prof. K. J. Moser, honorary chairman, told of plans for a field trip to the New York plant of the Borden Ice Cream Company. A film entitled "The Powerhouse of Aviation" was shown, through the courtesy of Curtiss-Wright.

### Tufts College Branch

A very interesting and educational meeting was held at Robinson Hall on Sept. 15, when two reels of films which had been loaned by the Navy, were shown. The first, a film on Diesel engines, pictured the development of the engine from the early stages up to the present-day refinement. The other film depicted the history of naval aviation.

On Sept. 23 a field trip was taken under the direction of Prof. David Fisher, junior member A.S.M.E., to inspect the Town of Hudson, Mass., light and power department. The plant was of special interest to the group because this municipal plant produces its power from six huge Diesel engines.

### University of Washington Branch

At the Sept. 19 meeting in the Guggenheim Auditorium, J. M. Consley, head of the steam division of the Westinghouse Electric Corporation's branch in Seattle, Wash., presented a brief history of steam turbines in marine propulsion, illustrating his talk with a series of slides showing units used in ships of World War II. He pointed out that turbines proved highly successful during the war, not only for propulsion but for such purposes as auxiliary lighting. The slides showed various types of turbines used in merchant and naval ships; many of the units were partly assembled, giving an idea of the size and proportion of the power plants. Many of these slides were used for navy reference, and Mr. Consley could not show them publicly until the war ended.

### University of Wisconsin Branch

At the meeting on Sept. 25 in Wisconsin Memorial Union, Mr. Schudt, student chairman of the Milwaukee Section of S.A.E., and E. L. Dahlund, chairman of the Rock River Valley Section, A.S.M.E., addressed the audience about their respective societies. Several other prominent out-of-town visitors were also introduced by George Hlavka, chairman.

The speaker was Dr. J. T. Rettaliata, junior member A.S.M.E., formerly director of the research and gas turbine development department of Allis Chalmers Manufacturing Company. Dr. Rettaliata gave a very interesting and enlightening talk on the gas turbine. His lecture was in four parts, illustrated with slides. The first part dealt with the history of the gas turbine; the second with its construction; the third with the thermodynamics of the cycle, which Dr. Rettaliata claimed was a necessary evil; and the fourth with the applications of the gas turbine.

## A.S.M.E. Medals and Honorary Memberships to Be Conferred at the Coming 1945 Annual Meeting

AT the Annual Meeting of The American Society of Mechanical Engineers to be held at the Hotel Pennsylvania, New York, N. Y., Nov. 26–30, 1945, awards and honors for the year 1945 will be conferred, with the customary impressive ceremonies.

*Honorary Membership* to Rear Admiral Harold Gardiner Bowen, U.S.N., Naval Research Laboratory, Anacostia Station, Washington, D. C.

*Honorary Membership* to Dugald Caleb Jackson, professor emeritus of electrical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

*Honorary Membership* to Andrey Abraham Potter, Past-President, A.S.M.E., and Dean of Engineering, Purdue University, Lafayette, Ind.

*Honorary Membership* to Sir William Stanier, The London, Midland and Scottish Railway, The Grove, Watford, Herts, England.

*Honorary Membership* to Dr. Wong, Wen-hao, vice-president of the Executive Yuan, Ministry of Economic Affairs, Chungking, China.

*A.S.M.E. Medal* to William Frederick Durand, "world-renowned authority in hydrodynamic and aerodynamic science and its practical application; great teacher with an inspiring character and a unique capacity for lucidity and simplicity in imparting highly technical material; trusted adviser to government in the solution of many intricate scientific problems in peace and during two world wars."

*Holley Medal* to Sanford A. Moss "for his many contributions over a long period of years to the development of centrifugal compressors, particularly as related to the highly successful application of turbosuperchargers to internal-combustion engines in the field of aeronautics."

*Worcester Reed Warner Medal* to Joseph M. Juran "for his outstanding contribution to the problem of quality control in mass production and his splendid records of such work as are contained in his books 'Bureaucracy, a Challenge to Better Management' and 'Organization and Management of Quality Control.' "

*Meville Prize Medal for Original Work* to William Julian King for his paper "The Unwritten Laws of Engineering."

*Junior Award* to Bruce D. Del Mar for his paper "Presentation of Centrifugal Compressor Performance in Terms of Nondimensional Relationships."

## Woman's Auxiliary to A.S.M.E. to Hold Annual Meeting on Nov. 28

THE twenty-second annual meeting of the Woman's Auxiliary to the A.S.M.E. will be held in New York during the week of November 26.

Mrs. Earl B. Smith and her committee are planning an interesting program. The annual meeting will be held on Wednesday, November 28, at the Hotel Pennsylvania and will be followed by a luncheon at the Engineering Woman's Club, 2 Fifth Avenue.

The Metropolitan Section, as hostesses, extend a cordial invitation to all women attending the A.S.M.E. Annual Meeting to participate in any or all of the activities.

All women in attendance at the meeting should register at the Women's Headquarters at the Hotel Pennsylvania.

# Actions of A.S.M.E. Executive Committee

## At a Meeting Held at Headquarters, Sept. 26, 1945

A MEETING of the Executive Committee of the Council of The American Society of Mechanical Engineers was held at Society headquarters on Sept. 26, 1945. There were present: Alex D. Bailey, chairman, R. F. Gagg, vice-chairman, A. C. Chick, D. W. R. Morgan, and A. R. Stevenson, Jr., of the Committee; J. J. Swan (Finance); A. R. Mumford (Sections); K. W. Jappe, treasurer; R. M. Gates, past-president; D. Robert Yarnall, president-elect; C. E. Davies, secretary; and Ernest Hartford, executive assistant secretary. The following actions were of general interest.

### A.S.M.E. 1945 Annual Meeting

Because of the lifting of the ban on conventions, the Committee on Recommendation of the Committee on Meetings and Program authorized the regular Annual Meeting of the Society, to be held during the week of Nov. 26, 1945.

### Standardization

A report of a Policy Committee on standards, set up by the Secretary of Commerce under the chairmanship of C. E. Wilson, member A.S.M.E., president, General Electric Company, which was submitted to the President and Secretary of A.S.M.E., recommended "that in full co-operation with the Federal Government, industry exercise vigorous leadership in the development of standards, through trade and technical associations, spearheaded by the American Standards Association. Standards constitute one of the most significant fields of industry-government relations," the report declared. "It is important for top management to give attention to the subject of standards and to provide for their orderly development. In standardization activities the Federal Government can make its most valuable contribution by developing needed technical data by means of research and factual studies, rather than by operating a standardizing agency."

Mr. Wilson asked the Society to support this policy, and the Executive Committee voted "that the Society reaffirms its interest in industrial standardization and is prepared to support an active program for the development of standards in the mechanical field under the procedure of the American Standards Association."

### Mack Printing Company

On recommendation of the Committee on Publications it was voted to invite Harvey F. Mack, of the Mack Printing Company, Easton, Pa., printers of MECHANICAL ENGINEERING and other Society publications for twenty-five years, to attend a luncheon to commemorate this long period of pleasant relationship of the two organizations.

### Boiler Code

The Council action of Oct. 13, 1916, was amended to read: "That each state and municipality in the United States and each province in the Dominion of Canada that adopts or accepts one or more sections of the Boiler Code be invited to appoint a representative to act on the Conference Committee to the Boiler Code Committee, the Conference Committee to consist solely of such members.

### Committee on Organization

Approval was voted of the recommendation of the Committee on Organization that the Board on Honors be made up of two members of the Council and five members-at-large, appointed one each year by the Council, each serving five-year terms; and that the functions of this Board be "in accordance with broad policies approved by the Council, select the recipients of honors, medals, and honorary memberships;" and "upon request of A.S.M.E. delegations on joint boards of award, nominate possible recipients of joint medals."

### Society Policy

In order to improve the services of the Society and to meet demands for postwar activities, the Executive Committee authorized the appointment of a Survey Committee of three to study and report on: (1) Analysis of the present activities and approximate value of each as measured by member participation; (2) development of schemes of activities and publications better to meet the technical interests of members; (3) critical discussion of these schemes with estimates of comparative costs; and (4) plan for providing services and activities under a scheme of charges for the specific service rendered.

### Gantt Medal

It was reported that the 1945 Gantt Medal was conferred on John M. Hancock, of Lehman Brothers, New York, N. Y., "in recognition of his part in the formulation of national policy for the successful prosecution of war and for economic progress in peace."

### Joint Committee on Postwar Planning

It was voted to withdraw A.S.M.E. representation on the Joint Committee on Postwar Planning.

Leonard J. Fletcher, of Peoria, Ill., was designated A.S.M.E. representative on the Joint Committee on the Economic Status of the Engineer, to fill the vacancy caused by the resignation of L. A. Appley.

### Selective Service Act

At a conference of representatives of 13 engineering and scientific societies held in Washington a resolution was prepared asking the Congress to modify the Selective Service Act so that young men qualified to undertake an engineering or scientific education could be assigned to engineering schools for their draft period. Approval of this resolution was voted by the Executive Committee.

### Control of German Industry

It was reported that the representatives of five engineering societies, R. M. Gates representing A.S.M.E., had released a report of the study by leading engineering and technological specialists embodying a program for the control of German industry to prevent rearmament.

### U. S. Chamber of Commerce

The Secretary was designated to attend a meeting on Nov. 1, 1945, at the invitation of the U. S. Chamber of Commerce, of a Construction Industry Advisory Council, which is being organized "to help develop construction-industry opinion and to make recommendations for industry and government action in public interest."

### Appointments

The following appointments were approved:

Committee on International Relations, Harry S. Rogers.

Committee on Policy for Admission of Chinese Members, Howard Coonley, chairman (International Relations), S. D. Sprong (Admissions), and J. N. Landis (Finance).

Daniel Guggenheim Medal Board, A. R. Stevenson, Jr. (three years).

National Management Council, William R. Mullee (three years); D. B. Porter, alternate; Fenton B. Turck, alternate to J. M. Juran (replacing L. A. Appley).

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# A.S.M.E. Sections

## *Coming Meetings*

*Central Illinois.* November 8. Bradley Hall, Bradley Polytechnic Institute, Peoria, Ill., at 8:00 p.m. Subject: "Our Part in Solving Today's Management Problems," by Dr. Lillian M. Gilbreth, A.S.M.E. Lecturer and consulting management engineer, Montclair, N. J.

*Cincinnati.* November 6. Dinner at 6:30 p.m.; meeting at 8:00 p.m. in Herman Schneider Memorial Building, McMillan at Woodburn, Cincinnati, Ohio. Subject: "The Engineer's Place in Industrial Personnel and Operating," by Dr. Lillian M. Gilbreth, consulting management engineer, Montclair, N. J.

*Chicago.* November 6. 7:30 p.m. at the Civic Opera Building, sixth floor, Little Theatre, Chicago, Ill. This meeting will be sponsored by the Power and Fuels Divisions of the A.S.M.E. Subject: "Kodachrome Films Showing Studies of Fuel Beds and Furnace Conditions." To be elaborated upon with an accompanying talk by Otto de Lorenzi, director of education, Combustion Engineering Company, Inc., New York, N. Y.

November 19. Dinner at 6:30 p.m.; meeting at 7:30 p.m. at the Museum of Science and Industry, 57th St. & South Shore Drive. Dinner will be in the cafeteria; meeting will be held at the Little Theatre. Topic and speaker to be announced.

*Detroit.* November 6. Dinner at 6:30 p.m.; meeting at 8:00 p.m. at the Rackham Building, Detroit, Mich. Subject: "Inside A.S.M.E.," by a national officer of the A.S.M.E.

*Louisville.* November 7. 8:00 p.m. in Speed Auditorium, Speed Scientific School, South Side of Eastern Parkway, University of Louisville, Louisville, Ky. Subject: "Our Part in Solving Today's Management Problems," by Dr. Lillian M. Gilbreth, consulting management engineer, Montclair, N. J.

*Minnesota.* November 13. Subject: "Streamlining Management," by Thomas S. McEwan, Regional Vice-President for Group VI, A.S.M.E.

*Plainfield.* November 21. Plainfield, N. J., at 8:00 p.m. Subject: "Electronics," by

E. K. Murphy, engineering department, Westinghouse Electric Corporation.

*Providence.* November 6. Providence Engineering Society Building, 195 Angell St., Providence, R. I., at 8:00 p.m. Subject: "What Management and Labor May Expect of Job Evaluation," by Asa S. Knowles, dean and director, School of Business Administration, Rhode Island State College.

*St. Joseph Valley.* November 9. Engineering Building, Notre Dame University, South Bend, Ind., at 8:00 p.m. Meeting sponsored by St. Joseph Valley Section, A.S.M.E., in cooperation with the Indiana and Michigan Industrial Engineers. Subject: "Our Part in Solving Today's Management Problems," by Dr. Lillian M. Gilbreth, consulting management engineer, Montclair, N. J.

*West Virginia.* November 5. 7:45 p.m. at the Daniel Boone Hotel, Charleston, W. Va. Subject: "The Engineer's Part in Solving Postwar Management Problems," by Dr. Lillian M. Gilbreth, A.S.M.E. Lecturer and consulting management engineer, Montclair, N. J.

*Metropolitan*

November 7, 7:30 p.m., Room 502.[1] "Metal Spinning by Modern Methods," by Edwin Weiss, chief engineer, Milwaukee Spinning Co., Milwaukee, Wis.

November 8, 7:30 p.m., Room 1105.[1] Forum. "Interesting Experiences."

November 8, 7:30 p.m., Room 502.[1] "Manufactured Gas Production," by A. B. Huyck, engineer in charge of manufacturing, Brooklyn Union Gas Co., and R. E. Schneiter, assistant engineer, process engineering department, Consolidated Edison Co.

November 9, 7:30 p.m., Room 503.[1] "Theory and Applications of the Unsymmetrical Beam," by Ernest A. Brooks, design engineer, Babcock & Wilcox Co., Barberton, Ohio. "Model Tests of Unsymmetrical Beam," by Lambert F. Kooistra and R. U. Blaser, research engineers, Babcock & Wilcox Co., Barberton, Ohio.

November 9, 7 p.m., Room 501A.[1] Junior Group Business Meeting.

November 13, 7:30 p.m., Room 502.[1] Joint Meeting of American Welding Society and A.S.M.E.: "The Effect of Plate Widths on Fabrication Costs of Pressure Vessels," by W. G. Theisinger, assistant to vice-president, Lukens Steel Co., Coatesville, Pa.

November 16, 7:30 p.m., Room 503.[1] "Chemical Cleaning and Heat Transfer on Process Equipment," by H. Liggett Gray, vice-president, Oakite Products, Inc., New York, N. Y., and F. N. Alquist, director of research, Lowell, Inc., Tulsa, Okla.

November 20, 7:30 p.m., Room 502.[1] "Anthracite Stoker-Fired Boilers," by C. H. Bean, supervisor of engineering of power plants, Calco Chemical Division, American Cyanamid Co.

November 20, 7:30 p.m., Room 503.[1] "Press Photography—Story Behind the Picture," by Jos. Costa, *N. Y. Daily News.*

November 27, Hotel Pennsylvania. Two Sessions jointly sponsored by the National Division and Metropolitan Section Rubber and Plastics Division. Three papers on Plastics will be presented at the morning session at 9:30 a.m. Four papers will be presented at the afternoon session at 2:30 p.m.

November 28, Hotel Pennsylvania. Woman's Auxiliary Business Meeting at 10:30 a.m. Woman's Auxiliary Annual Luncheon meeting at 1 p.m. at Engineering Woman's Club, 2 Fifth Ave., New York, N. Y.

*Cleveland.*

November 8. Cleveland Engineering Society Rooms, Cleveland, Ohio at 8:00 p.m. Subject: "Locomotive Power Characteristics," by Dr. Rupen Eksergian, chief consulting engineer, Edward G. Budd Mfg. Co., Philadelphia, Pa.

November 27 8:15 p.m. Grand Ballroom, Hotel Pennsylvania, "Origin & Development of PT Boat and High-Speed Deep-Sea Air or Sea Rescue Vessels," by Hubert Scott-Paine, British engineer and industrialist, Marine Designing and Engineering Development Corporation, Greenwich, Conn.

## Engineering Societies Personnel Service, Inc.

***These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative, nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient, nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.***

**New York**
**8 West 40th St.**

**Chicago**
**212 West Wacker Drive**

**Detroit**
**109 Farnsworth Ave.**

**San Francisco**
**57 Post Street**

### MEN AVAILABLE[1]

MECHANICAL ENGINEER, 26, married, four years' experience production engineering. Phi Beta Kappa. Good personality and health. Engineering work involving personal and outside contacts desired or assistant to consulting engineer. Me-941.

TOOL ENGINEER, 30, married, graduate mechanical engineer, top school. Six years' experience in tool design and production engineering. Desires permanent position with long-established concern. Me-942.

GRADUATE MECHANICAL ENGINEER, 26, married. Army officer anticipating release from active duty seeks permanent position as development, maintenance, or sales engineer with small or middle-sized Eastern organization. Three years' experience in diversified testing, liaison, and development engineering for A.A.F. Me-943.

GRADUATE MECHANICAL ENGINEER, 26, married. One year aircraft manufacturing production, limited time study experience, three years' Diesel shipboard operation and maintenance, one year Diesel engine repair. Desires developmental, sales or field service work in gas turbine field. Location not essential. Available January, 1946, upon discharge from U. S. Navy. Me-944.

TECHNICAL WRITER with over ten years' experience preparing specifications, standards, handbooks, instruction manuals, reports, magazine articles, etc. Technical Editor of trade magazine, with major circulation, for one year. Me-945.

WORKS MANAGER OR EXECUTIVE, 42. Best qualified in administration and development of organization. Experience in production engineering and supervision, general and cost accounting, industrial heating sales, engineering and market analysis. Me-946.

MECHANICAL ENGINEER, 30, eight years' experience. Design of punches and dies, tools, fixtures, automatic and semiautomatic machines for small metal products. Design and development mechanical devices for experimental use. Me-947.

MECHANICAL ENGINEER, graduate, 24, single. Desires laboratory position along experimental development in power, air conditioning, or instrument industries. One year's experience on aircraft carburetor development. Middle West. Me-948.

MECHANICAL ENGINEER, graduate, 29. Nine years' varied experience on precision instruments. Four years as manufacturing engineering supervisor, two years assistant production manager, two years design, one year materials laboratory. Me-949.

MECHANICAL ENGINEER, Cornell graduate, registered Pennsylvania; thirty-four years' experience, power plants, chemical and process industries; design, construction, purchasing, operation, development of new equipment and processes; consulting. Prefer East, Middle West, South. Me-950.

GRADUATE MECHANICAL ENGINEER, 29, married, experienced in quality control and inspection supervision on diversified mechanical materials, work simplification, diagnosing inspection troubles. Quality control engineering position desired South or East. Me-951.

ENGINEER, 33, married, $6\frac{1}{2}$ years' broad mechanical-metallurgical (ferrous) experience in brass mills and extensive metal fabricating operations plus $2^1/_2$ years' responsible production and contract administration. Naval release early 1946. Available for technical, administrative, or executive position. Me-952.

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[1] Engineering Societies Building, 29 West 39th St., New York, N. Y.

[1] All men listed hold some form of A.S.M.E. membership.

Mechanical Engineer, 44, steam and gas turbine, supercharger, jet propulsion, centrifugal compressor, research, stress analysis, and design experience. Own patents pending. Also supervised shop equipment and tool design. Responsible position desired. Me-953.

Senior Engineering Executive seeks connection offering ample opportunity to expand markets, develop new products and processes; successful record chemical, metallurgical, sanitary fields. Twenty-five years' experience in organization, general and sales management; direction advertising, and patent and licensing projects; widely traveled here and abroad. Me-954.

Mechanical Engineer, 26, three years' experience designing electromechanical devices, one year testing experience, S.M. and S.B. degrees from M.I.T. Desires position as development or design engineer. Now employed. Me-955.

## POSITIONS AVAILABLE

Application Engineer, 30–35, mechanical graduate, to assist chief engineer in development, and to contact clients of the company. Should have experience on heavy presses and/or hydraulic machinery. Will be expected to do considerable traveling. $5000 year. Headquarters, New York, N. Y. W-5964.

Design Engineer, mechanical graduate, with at least ten years' experience in design and development of business machines. Experience with tabulating, sorting, and key-punch machines preferred. $6000–$8000 year. New York, N. Y. W-5972.

Manufacturer's Representative having engineering background, experience, and contacts essential to properly represent manufacturer of high-pressure boilers. Exclusive territory. Headquarters, Michigan. W-5975.

Manufacturing Engineer, mechanical graduate preferred, with broad experience in handling and forming of sheet metal. Must be familiar with drawing, bending, punching, and hand-forming processes; welding and bracing of sheet metals and be expert at die designing; familiar with lofting processes; and capable of working out with contractors processing and manufacturing of sheet metal parts and equipment. Permanent. $4200–$6000 year. Pennsylvania. W-5979.

Engineers. (*a*) Industrial Engineer, 25–38, with good educational background and possessing potential administrative and executive ability. Should be capable of becoming assistant manager in Standards Department. Salary, $4800–$600 year. (*b*) Can Manufacturing Assistant, 25–38. Must have experience in can manufacturing. $4800–$6000 year. (*c*) Time and Motion Study Analyst, 25–38, with actual experience in time and motion study. Opportunity. About $2500 year, for 40-hour week. (*d*) Assistant to Plant Engineer, 30–40, civil or mechanical graduate preferred. Must have experience in construction work and industrial building equipment. $3900–$5100 year. New Jersey. W-6005.

Chief Engineer, mechanical graduate, with at least ten years' experience in textile-machinery field, in design, manufacturing, and field work. Must have several years of executive and administrative engineering experience. Intimate knowledge of past and current textile-mill practices is essential. Salary open. Rhode Island. W-6011.

Mechanical Engineer with experience in machine factories, preferably on packaging and/or paper converting machines, to organize engineering staff. Will supervise production and must make his own layouts and designs. $8000–$10,000 year. New York, N. Y. W-6016.

Assistant Production Superintendent, 40–45, mechanical graduate preferred, with paperboard conversion experience for paperboard manufacturer. Must have working knowledge of wage incentive plans and cost control methods. $6000 year. New England. W-6017.

Plant Development Engineer, graduate, 35–45. Must have plant experience in design and construction in chemical, food, process, or similar plants; some knowledge of maintenance problems. Must be of top ability and capable of holding down top executive position. $7000 up year. Northern New Jersey. W-6049(a).

Chief Plant Engineer, mechanical graduate, with some experience in milk-plant field. Must know refrigeration, boilers, and general plant maintenance. Company operates five plants in middle New York State. $5000 year. W-6051.

Engineers. (*a*) Chief Engineer, about 40, mechanical graduate, to head up engineering department and machine and tool room. Would be expected to set up standard practices where needed. Should have good knowledge of design and machine shop practices and be good executive. Salary, about $6000 year. (*b*) Machine Designer for design of special machinery, involving designing equipment, following through its manufacture, putting it into production, etc. Some board work involved. Salary, about $3900 year. (*c*) Tool Designer for design of tools for turret lathes and automatic screw machines, including cam design, jigs and fixtures, etc., for manufacturer of metal hose. About $3900 year. Connecticut. W-6056.

Mechanical Engineer with experience in steam and qualified to design boiler and turbine facilities for 35,000 KVA steam electric plant. Should be competent to examine plant and develop designs for its rehabilitation. Permanent. $6000–$7200 year. Florida. W-6082.

Chief Industrial Engineer, about 40, to supervise work of industrial engineers on plant layouts, work stations, material flow, time study, etc. Supervise facilities utilization, manufacturing capacities, etc.; direct department; build up and train industrial engineers; provide factory supervision with adequate control information. Should have wide experience in industrial engineering. $7500 a year. Eastern United States. W-6085.

Engineer with technical and practical experience for manufacturer of bone products. Should have experience in operation of such a plant and be capable of planning layout of factory for such products on most-up-to-date lines. Will act in advisory capacity with regard to machinery required for various processes; assist in manufacture of equipment, and advise with respect to probable sources of supply of machinery that must be imported. Must be capable of supervising assembling and erection of such machinery. Three-year contract. Salary open. India. W-6087.

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# Candidates for Membership and Transfer in the A.S.M.E.

The application of each of the candidates listed below is to be voted on after November 24, 1945, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

### KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

### NEW APPLICATIONS

*For Member, Associate, or Junior*

Agnew, John T., Lafayette, Ind.
Anderson, Paul W., New York, N. Y.
Baan, George B., Norwalk, Conn.
Ball, Frederick S., Chestnut Hill, Pa.
Barkovitz, William E., Lincoln Park, Mich.
Beuter, A. J., Philadelphia, Pa. (Rt)
Black, William S., Chicago, Ill. (Re)
Bradford, G. A., Islington, Ontario, Can.
Burke, Edward, Pittsburgh, Pa.
Callouette, John E. (Lieut.), Bremerton, Wash.
Campbell, Donald, Cambridge, Mass.
Canty, D. J., Jr., Pittsburg, Calif.
Chandler, Thompson, S. Charleston, W. Va.
Christensen, Oscar, Shelton, Conn. (Rt)
Cleary, George F., San Leandro, Calif.
Connors, Robert T., Philadelphia, Pa.
Curtis, Bruce D., Washington, D. C.
Dabney, R. R., San Antonio, Texas
Dahl, Norman F., Brooklyn, N. Y.
DeBodor, Andor, Glen Ridge, N. J. (Rt)
Deimer, Wm. H. L., Cheviot, Ohio (Rt & T)
DeLaney, James Cecil, Jr., Houston, Texas
Dixon, J. K., Milwaukee, Wis.
Dohn, Charles Walter, Brooklyn, N. Y.
Douglass, Dwight, Hartford, Conn.
Downs, J. N., Doylestown, Ohio (Rt & T)
Dutton, Robert H., Oakland, Calif.
Eaton, William Fay (Lieut.), Berkeley, Calif.
Engelson, Howard R. (Lieut.), Valdosta, Ga.
Epstein, Seymour, Brooklyn, N. Y.
Evans, D. H., Clarkson, Ontario
Figenschou, Rasmus, New York, N. Y.
Foote, S. D., Calgary, Alberta
Fox, Sanford W. (Lieut.), San Francisco, Calif.
Freis, Frederick M., Chicago, Ill.
Frick, Robert J., Pittsburgh, Pa.
Gale, Albert G., Boxford, Mass.

Garbark, Roman F., Westchester, Ill.
Gillette, Edward H., New York, N. Y.
Goglia, Gennaro L., Fort Wayne, Ind.
Grandin, Frederick, Wharton, N. J.
Gruenberg, Emil, New York, N. Y.
Guillou, Rene, Los Angeles, Calif.
Guins, V. G., Palo Alto, Calif.
Hadden, George L., Shadyside, Ohio
Hallock, Richard W., Scotia, N. Y.
Harkenrider, Robert J., Newport, Del.
Hilton, Earl, San Francisco, Calif.
Holowenko, Alfred R., Houston, Texas
Hosford, Eugene, Mt. Pleasant, Mich.
Huff, Howard W., Akron, Ohio
Jagannathan, M. V., Madras, India
Kelly, J. L., Cleveland, Ohio
Knopf, K. K., San Mateo, Calif.
Liebenthal, John H., Jr., Chicago, Ill.
Livingston, Robert T., New York, N. Y. (Rt)
Mabie, Hamilton H., Ithaca, N. Y.
Malzahn, Gus E., Perry, Okla.
Marggraff, F. C., Jr. (Comdr.), Annapolis, Md.
Marx, Harry J. (Comdr.), Arlington, Va.
Mather, Joseph W., Santa Fe, N. M.
McCready, John T., Concord, Calif.
McGladrey, Lyle L., Yellow Springs, Ohio (Rt & T)
McVeigh, J. R., Greensburg, Pa.
Meiners, Eugene B., St. Louis, Mo.
Meykar, Orest A., New York, N. Y.
Mitchell, James R., Jr., Coatesville, Pa.
Mukerji, Anadi Nath, Calcutta, India
Murphy, Glenn, Ames, Iowa
Murphy, Moyes J. (Lieut. Comdr.), Alexandria, Va.
Napier, David J., Toronto, Ontario
Newton, George H., Drexel Hill, Pa.
Nixon, Boris C., Akron, Ohio (Rt & T)
Openshaw, A. B., Chicago, Ill.
Palmatier, E. P., Solvay, N. Y.
Patterson, George A., Jr., Seattle, Wash.
Patton, Fred T., Berkeley, Calif.
Pawlowski, Bruno J., Haddon Heights, N. J.
Pegler, James Leon, Elizabeth, N. J.
Perelman, Albert A., Brooklyn, N. Y.
Pettebone, Orlando R., Oakland, Calif. (Rt & T)
Pettibone, Raymond B., Detroit, Mich.
Plum, Charles R., Seattle, Wash (Re)
Powell, C. H., Amityville, N. Y.
Propper, Clayton H., Kent, Ohio
Pruden, Worrell F., Los Angeles, Calif.
Putnam, W. J., Nashville, Tenn.
Raczynski, Anthony F., Pottstown, Pa.
Rathaus, J. T., Stratford, Conn.
Rede, G. Ross, Schenectady, N. Y.
Roe, Kenneth A. (Lieut.), Upper Darby, Pa.
Rowley, Alfred W., Cumberland, Md.
Saff, Leonard, Olean, N. Y.
Savarese, James J., Union, N. J.
Schneider, Arthur, Alameda, Calif.
Schor, Robert, Brooklyn, N. Y.
Schroeder, Henry Charles, Chicago, Ill.
Seale, William J., Schenectady, N. Y.
Seely, Ralph W., Pasadena, Calif.
Sepic, Joseph B., Pittsburgh, Pa.
Severy, Lawrence A., Southbridge, Mass.
Sharpe, Irwin P., Jamaica, N. Y.
Shively, John J., New York, N. Y. (Rt & T)
Smith, Spencer Gray (Lt.), New Orleans, La.
Taylor, Arthur H., Newton, Iowa
Thompson, Edward C., Denver, Colo.
Thompson, Elliott R., Trenton, N. J.
Tolman, Lee P. (Capt.), Kew Gardens, N. Y.
Tompkins, Harold W. (Lieut.), Glenolden, Pa.
Trickett, Joseph M., San Francisco, Calif.
Unger, G. E., Lima, Peru
Ungerleider, Samuel A., East Orange, N. J.
Van Buskirk, J., Evanston, Ill. (Rt & T)
Welsh, Harvey W., Paterson, N. J.
Wheaton, Henry C., New York, N. Y. (Rt & T)
Wherritt, Charles R. (Lieut.), Arlington, Va.
Whipple, J. H., Jr., Denver, Colo.
Wier, Robert L., Detroit, Mich.
Wills, N. James, Montreal, Quebec
Wood, Orville T., Clinton, Mass.
Young, Clem J. (Lieut.), Aberdeen, Md.

### CHANGE OF GRADING

*Transfers to Fellow*

Colvin, Charles H., New York, N. Y.
Harrison, R. E. W., St. Thomas, Pa.
Ostermann, R. M., Evanston, Ill.
Woolrich, W. R., Austin, Texas

*Transfers to Member*

Adams, Richard D. (Comdr.), Ambridge, Pa.
Amorosi, Alfred M., Washington, D. C.
Andromidas, Thomas T., Philadelphia, Pa.
Aronson, Carl A., Syracuse, N. Y.
Barten, E. A., Cheltenham, Pa.
Bell, Melvin, East Chicago, Ind.
Biddle, Walter A., Albuquerque, N. M.
Brenner, K. W., Rochester, N. Y.
Brownscombe, Philip J., Brooklyn, N. Y.
Cassidy, T. Francis, Jr., Wethersfield, Conn.
Clement, George P., New York, N. Y.
Cooper, Lemuel B., Seattle, Wash.
Cyrol, E. A., Chicago, Ill.
Delmonte, John, Glendale, Calif.
Dexter, H. W., Jr., Pittsburgh, Pa.
Duni, Robert L., Torrance, Calif.
Erickson, Edward A., Columbus, Ohio
Flint, Thomas, Concord, Mass.
Forrest, H. Dean, Alexandria, Va.
Geissbuhler, John O., South Euclid, Ohio
Green, Andrew S., Richmond, Calif.
Guss, Edward, Arlington, Va.
Hamilton, Arthur S., Jr., Rochester, N. Y.
Hay, B. W., Oak Ridge, Tenn.
Honecker, Norman C., Waban, Mass.
Hunter, Anthony, Asbury Park, N. J.
Jeffcock, H. W., Baldwinsville, N. Y.
Kaiser, Elmer R., Pittsburgh, Pa.
Knoedler, Elmer L., Jr., Baltimore, Md.
Kramer, Leo J., Camden, Ark.
Kuhns, R. L., Charleston, W. Va.
Lembcke, Robert K. (Lieut.), Fort Worth, Texas
Loman, John K., Kokomo, Indiana
Loonin, H. Howard, Brooklyn, N. Y.
Lord, G. Ross, Toronto, Ontario
Lyman, Theodore B., Berkeley, Calif.
MacHenry, Richard, Marcus Hook, Pa.
Marchant, Richard D., Pittsfield, Mass.
Marquis, F. P., Moline, Ill.
McKenna, Joseph F., Saginaw, Mich.
McNear, Wm. Fairlie, West Orange, N. J.
Meade, Leonard P., Bartlesville, Okla.
Meyer, Ira L., Philadelphia, Pa.
Miller, Newby L., Kansas City, Mo.
Moler, Frank W., Jr., New York, N. Y.
Neiman, Charles H., Jr., York, Pa.
Newbegin, John L., Chicopee Falls, Mass.
Northrup, Milton G., Los Angeles, Calif.
Otto, Charles R., Ithaca, N. Y.
Parrish, William C., Inglewood, Calif.
Pharo, C. W., St. Louis, Mo.
Pietsch, E. H., Desplaines, Ill.
Radamaker, G. L. (Lieut.), Detroit, Mich.
Reed, John C., Lewisburg, Pa.
Reeve, D. D., Beauharnois, Quebec
Reynolds, Spencer W., Westfield, N. J.
Ross, Hugh L., Milwaukee, Wis.
Schaeffer, Philip A. (Capt.), Arlington, Va.
Schmid, W. A., New York, N. Y.
Schwerin, Charles, Pittsburgh, Pa.
Sietsma, Stuart J. (Capt.), Lafayette, Ind.
Staber, George I. (Lieut. Comdr.), Oradell, N. J.
Stephan, E. R., Storrs, Conn.
Strassman, Robert C., Milwaukee, Wis.
Swannack, Jervis D., Beloit, Wis.
Theiss, Ernest S., Durham, N. C.
Tozer, Sydney J., Chicago, Ill.
Troger, Henry H., Port Newark, N. J.
Veck, Milton F., Buffalo, N. Y.
Whitaker, Randall J., Newport, R. I.
Wilson, Davis D., Fort Worth, Texas
Wilson, William B., East Lynn, Mass.
Winkler, Theodore E., Detroit, Mich.
Zuckerberg, Harry, New York, N. Y.
*Transfers from Student Member to Junior*......65

## Necrology

THE deaths of the following members have recently been reported to headquarters:

Bahnson, Frederic F., March 18, 1944
Buck, Charles P., July 25, 1945
Bush, Harold M., August 7, 1945
du Pont, William B., August 9, 1945
Epstean, Edward, August 8, 1945
Fisher, Frederick, July 30, 1945
Froelich, Frederick H., June 30, 1945
Gale, Philip B., July 25, 1945
Lister, Francis G., August 20, 1945
Nofsinger, Lewis E., July 14, 1945
Olson, Carl G., July 3, 1945
Poole, Ernest J., February, 1945

## A.S.M.E. Transactions for October, 1945

THE October, 1945, issue of the Transactions of the A.S.M.E. contains:

A Graphical Solution of Windshield Heat Deicing Problems, by H. H. Hauger, Jr.
An Acceleration Damper: Development, Design, and Some Applications, by Paul Lieber and D. P. Jensen
Heater Designs for the Petroleum Industry, by J. H. Rickerman
Cavitation in Centrifugal Pumps, by A. J. Stepanoff
Testing of Precision-Lathe Spindles, by G. M. Foley
Irreversibility in the Theoretical Regenerative Steam Cycle, by R. E. Hansen
Critical Shearing Stress in Skin-Stressed Boxcar Sides, by V. L. Green and J. J. Drinka
Creep and Relaxation in Rubber Products at Elevated Temperatures, by R. D. Andrews, R. B. Mesrobian, and A. V. Tobolsky
Investigation of Influence of Ring Size, Bobbin Diameter, and Spindle Speed on Spinning Process, and Their Effect on Over-All Cost of Spinning, by A. N. Sheldon and J. J. Blake
Experimental Study of the Flow of Coal in Chutes at Riverside Generating Station, by E. F. Wolf and H. L. von Hohenleiten

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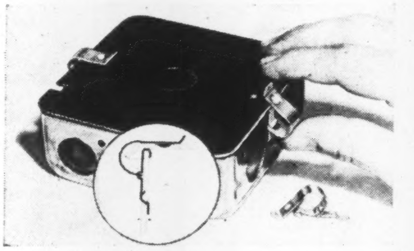
• BUSINESS CHANGES
• LATEST CATALOGS

Available literature may be secured by addressing a request to the Advertising Department of MECHANICAL ENGINEERING or by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as a source.

## • *NEW EQUIPMENT*

### New Box Cover Fastener



This ingenious spring steel fastener for box covers eliminates all screws, nuts and rivets, as well as tools for attaching. The clip is self-retaining and need only be snapped by hand into pre-punched holes in the sides of the box. It is low in cost, light in weight and installed more quickly. By merely flipping the clips into locked position, the cover is held firmly in place as shown in the illustration. To remove the cover, the clips are unsnapped by merely pushing them back with the thumb. These new clips are entirely outside of the box with nothing inside to obstruct or damage wires or other equipment.

Available for use on sheet metal, die cast, plastic or plywood boxes of varying wall thicknesses. When writing for samples, advise (1) material and (2) thickness of box and cover (3) whether loose fitting or close fitting cover. Manufactured by Tinnerman Products, Inc., 2124 Fulton Road, Cleveland 13, Ohio.

### Safety Vents

Safety vents with rupture diaphragm give a wide margin of protection against fire and explosion to tanks and processing vessels containing inflammable liquids.

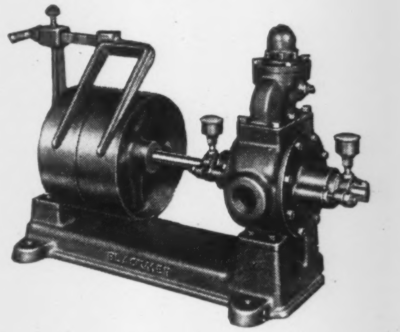
These units give double protection, in that they are a combination vapor valve and rupture diaphragm. They contain a special disc or rupture diaphragm that will break to relieve excessive pressures which build up within a storage tank. Thus, by permitting the escape of unusually high pressures, danger from explosions is reduced to a minimum, and human lives are protected and costly tank replacements are avoided.

In addition to the rupture diaphragm, these units have the ordinary function of permitting a safe escape of inflammable gases from a tank. This is accomplished by means of a specially designed unit with perforated brass flame barrier plates. Exhaustive tests have proven conclusively that this unique feature prevents flames from flashing back through the perforated vent plates into the tanks where inflammable liquids might be ignited.

Safety vents are made in cast bronze, steel, semi-steel or cast iron, with flange or butt-weld connections, in a wide range of sizes. Manufactured by the J. A. Zurn Mfg. Co., Erie, Pa.

### New Self-Adjusting Pumps for Cleaning Solvents

A line of flat-belt and direct motor drive rotary pumps in capacities from 10 to 750 GPM at pressures to 100 psi has been adapted to filter and transfer applications in dry cleaning plants. The 10, 20, 35 and 50 GPM units are now in production and available for reasonably prompt delivery. This information was released by J. B. Trotman, General Sales Manager of the Blackmer Pump Co., Grand Rapids, Mich.



The pumps are designed to operate on the "bucket design" (swinging vane) principle and because of this action are self-adjusting for wear. The Buckets (swinging vanes) move farther out of the recesses of the rotor as wear occurs at the tips. This compensating action maintains the normal capacity of the pump until the buckets are worn to the critical point, when they are replaced. To replace the buckets, the head plate of the pump is removed, the old buckets lifted out and new ones inserted. No adjustments are needed.

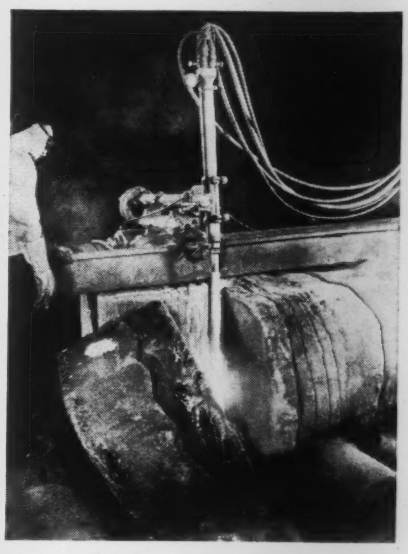
According to Mr. Trotman, this same type of pump is also furnished with removable liners, so that when the abrasive action of dirty solvent wears both liner and buckets may be installed. This operation does not disturb either piping or drive and is said to require but thirty minutes.

The units are shipped complete with tight and loose pulleys, belt shifter and bracket mounted on a common base or with motor. Blackmer Standard relief valves are optional equipment.

The new line of Blackmer solvent pumps will be sold through established supply houses.

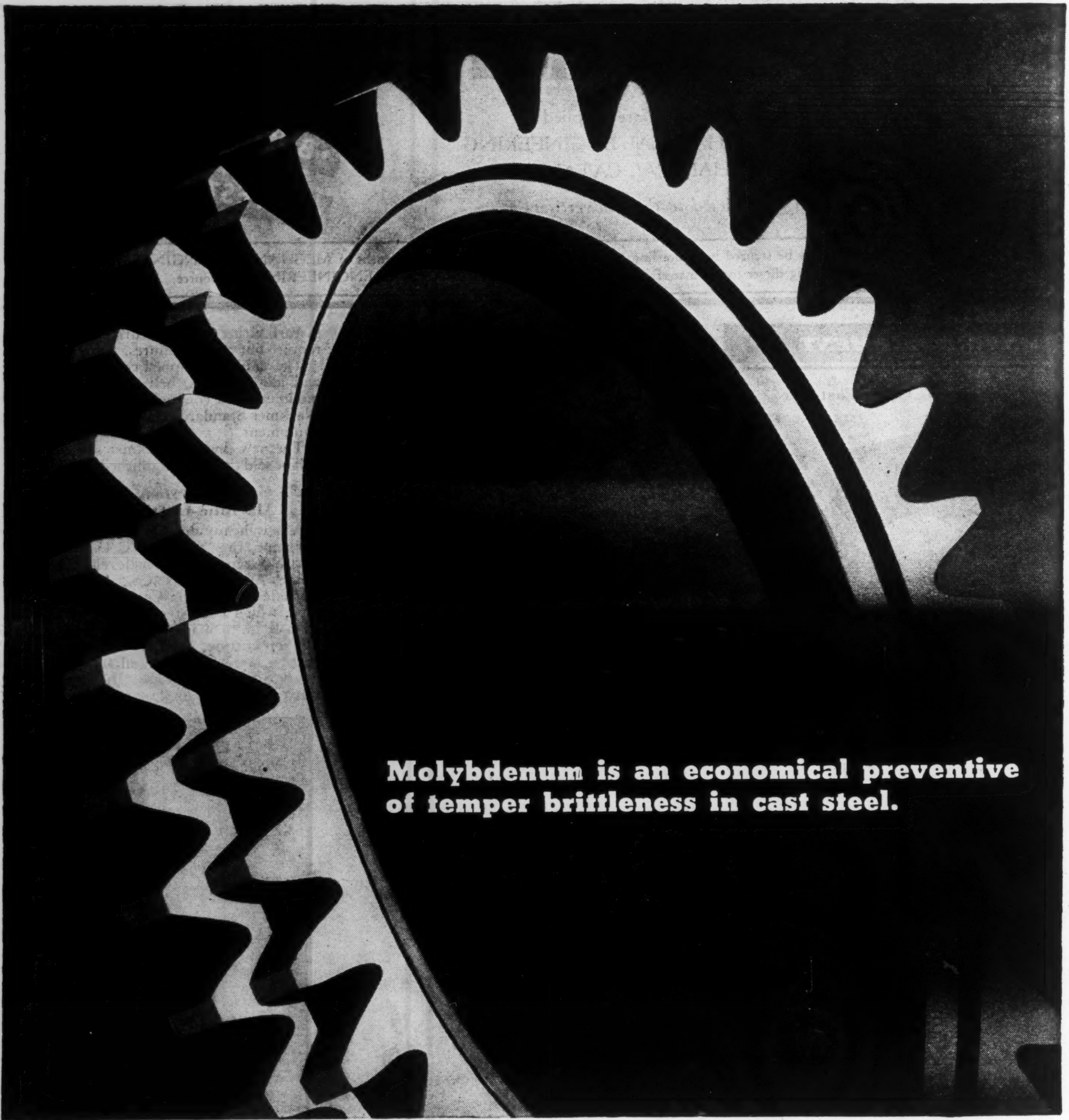
### A New Heavy-Duty Machine-Cutting Blowpipe

A new heavy-duty, oxy-acetylene cutting blowpipe, the "Oxweld" C-45 machine-cutting blowpipe, has been developed by The Linde Air Products Co., Unit of Union Carbide and Carbon Corp. This new blowpipe, which cuts steel ranging in thickness from 16 in. to 50 in., is particularly suited for hot top cutting, ingot slitting, riser cutting, cutting large forgings, and scrap cutting in many applications where the oxygen lance was formerly required.



The C-45 is water cooled and is intended to be mounted on a heavy-duty, straight-line cutting machine such as the new "Oxweld" CM-37 machine or the familiar "Oxweld" CM-21 cutting machine. A 50-lb. gauge is attached to the blowpipe body for checking cutting-oxygen pressures which are unusually low—never over 35 lb. per sq. in. The C-45 blowpipe is designed for operating with medium-pressure acetylene and will operate satisfactorily on a generator or a manifold having a minimum hourly capacity of 500 cu. ft. of acetylene. Unless cutting oxygen is supplied from a pipe line, at least 10 cylinders should be manifolded to provide sufficient capacity. In shops where steel over 18 in. thick must be cut frequently, the C-45 blowpipe provides a tool for making these cuts quickly and economically.

*Continued on Page 29*


Molybdenum is an economical preventive of temper brittleness in cast steel.

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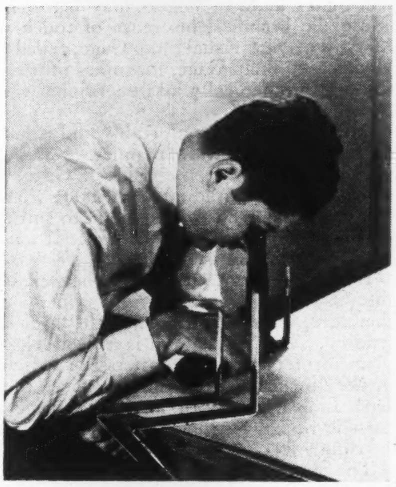
## • Keep Informed

Also available is the "Oxweld" C-45 blowpipe holder, which has been designed especially for this blowpipe. It provides ease, accuracy, and stability in making vertical and angular adjustments. Vertical adjustment is obtained by turning a ball crank which operates a worm and gear that meshes with the blowpipe rack. A total angular adjustment of 135 deg. can be obtained in the plane of the cut.

### Kodak's Transfax Helps Strain Analysis Studies

In practice, in the metal-forming industries, grid patterns to study strain analysis have been applied by more or less bothersome methods. The sample was formed and the lines reexamined under a low power microscope to determine the extent of their deformation in the forming process. The results showed engineers how the material intended for the forming operation would withstand the stresses imposed.



Both the Chicago plant of the Douglas Aircraft Company at Park Ridge, Ill., and Carnegie Illinois Steel in Pittsburgh, have, however, simplified the problem by employing a new light sensitive paint known as Transfax. The material is applied with an ordinary spray gun and a reduced negative of linear coordinate graph paper laid in contact with the metal and exposed for a few minutes to the light of a flood-type lamp.

The surface of the metal is washed with a weak solution of ammonia water and the fine grid lines remain as narrow white lines. These lines are examined with a low-power microscope which includes a reticle having accurately spaced parallel lines. By aligning the reticle pattern with the lines on the sample, the engineer can quickly tell the amount and direction of movement of the metal in the sample during the forming operation and this information is significant in light of past metallurgical knowledge of the metal used, since both elongation and compression of the material can be analyzed.

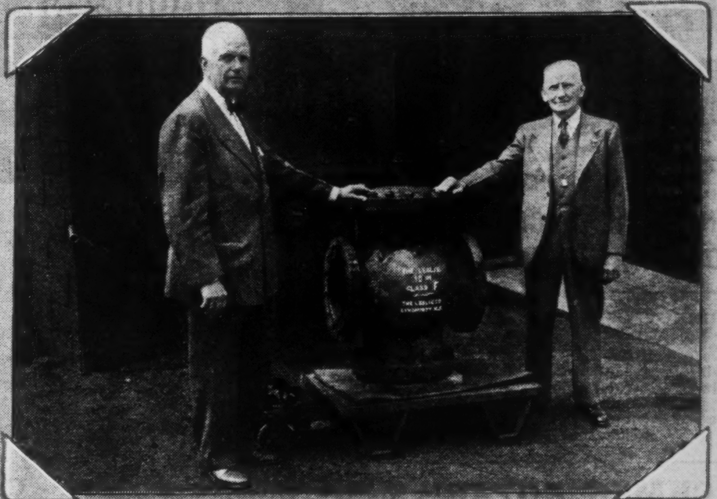
### New Type of Snap Gage

Federal Products Co., 1144 Eddy St., Providence, R.I., announces a new type of Snap Gage. Conventional type snap gages have changed but very little since they were first used to make the mass production of interchangeable parts possible.

This new Snap Gage takes the uncertainty out of the conventional "feeler" type of snap gage. It visualizes the actual dimension of the workpiece. It has all the simplicity, compactness and utility of the snap gage

*Continued on Page 30*

3 "OLD TIMERS"



**S. Inglis Leslie, President, and R. J. (Bob) McIlwain, oldest employee and foundry consultant, inspect 35-year old veteran LESLIE Reducing Valve.**

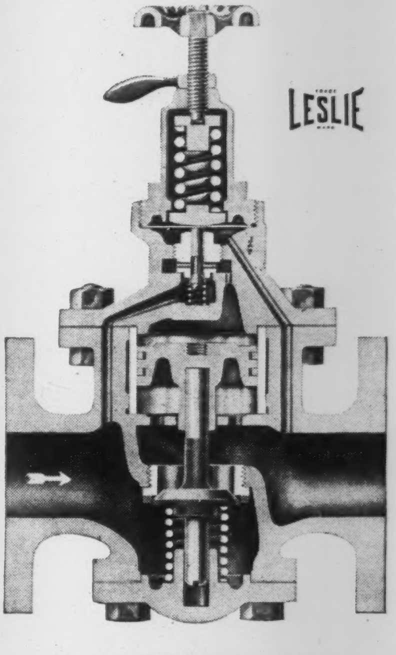
The above illustration marks three separate yet closely related records of service, each indicative of long-term LESLIE quality and reliability.

For, the recent arrival of a 10 in. LESLIE Class F Reducing Valve back for its first repairs after 35 years of hard service, likewise marked 40 years of service with LESLIE CO. of two men closely identified with long-life records of LESLIE Products.

This Reducing Valve, used for controlling steam to reciprocating engines, needed only minor repairs. Following that, it was again returned to the same service, after receiving (and successfully standing) the same rigid maximum steam pressure and operating tests which it underwent prior to shipment 35 years ago—ample indication of a quality that has kept abreast of the best in materials for regulator manufacturing and performance.

To borrow the words of one user, "These Reducing Valves give unbelievable satisfaction. Their constant reliable performance will please any engineer. They are as reliable as the setting sun."

SEND FOR your copy of Bulletin 401-A giving latest engineering data on Pressure Reducing Valves for steam and air service.



**Class L-3 LESLIE Pressure Reducing Valve, Self-contained, Spring loaded, internal pilot, piston operated.**

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*THIS MEANS SUSTAINED CAPACITY DEPENDABLE OPERATION AND LOWER PUMPING COSTS*

Write for Bulletin No. 307—Facts About Rotary Pumps

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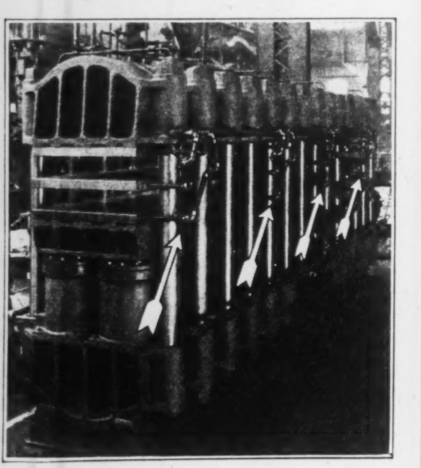
Just 4 Parts!

*Simple in design and construction: just four accurately machined bronze parts and an inner seal that keeps the joint tight. No ground surfaces to wear—no small parts to lose—no springs to break. They are safe, durable and efficient.*

FLEXO JOINTS

are used everywhere in industry to convey steam, air, water, gas, oil, and other fluids through pipe lines that must be moved or swung in different directions or to supply machinery or equipment with any fluid while in motion. 4 styles—pipe sizes from $\frac{1}{4}$ inch to 3 inches. All pressures to 1350 lbs. superheated steam.



*Hot plate hydraulic press. A uniform and dependable steam pressure maintained on the movable platens by using FLEXO JOINTS and pipe.*

A few uses for Flexo Joints:

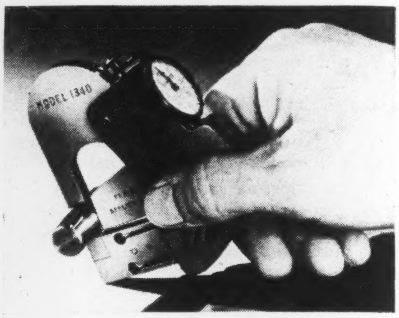
Blower and blow-off lines in railroad roundhouses—Track end connections in railroad yards and at terminals—Water-cooled furnace doors—Calenders—Steam heated presses of all kinds, vulcanizing, molding, hat, laundry, veneer, brick, etc.—Coating rolls—Laying pipe lines on pontoons—Oil burners—Testing blocks—Tank car connections—Revolving machinery—Pivot pin joints on locomotive cranes—Movable pipe lines in mines and quarries—Soot blowers—Steam heating oil lighters and barges—Steam jacketed mixers of all kinds—or any place a flexible or swing joint is required for steam, air, gas, water, or oil.

*Descriptive literature on request.*

FLEXO SUPPLY COMPANY, Inc.

4219 Olive Str. St. Louis 8, Mo.

with the addition of defining positively that there is a variation in the specified dimension and also in addition it tells how much the dimension varies.



You can magnify main strength by means of levers, but you cannot magnify the sense of touch. No matter how sensitive the nerves in a man's hand or fingers may be, or how skillful he becomes, his sense of touch will vary. This new visual Snap Gage, called our Model 1340 Snap Gage, magnifies impersonally and mechanically all dimensional variations.

It fits the hands comfortably and is handled in an entirely natural manner.

It is a single-purpose type of Gage, the dial of which is graduated in .0001″, has a range of .008″, and can be made to suit any dimension between $^{1}/_{8}''$ and $1^{1}/_{2}''$. It weighs only approximately seven ounces.

It is important to note that the weight of the Gage rests on the rigid upper anvil, therefore, it cannot influence the Indicator reading. The lower anvil is a flexible, solid piece of metal which transfers the variation in the dimension from the workpiece to the Dial Indicator. Both anvils are tungsten carbide tipped for long wear. It has an insulating finger grip.

The instrument promises to be one of the most revolutionary instruments in the Snap Gage class of Gages.

### Radiotelephone Rates to Hawaii, Puerto Rico, and Alaska Reduced

Rates for overseas radiotelephone service between the mainland of the United States and Hawaii, Puerto Rico, and Alaska will be reduced beginning on November 1, according to an announcement of the American Telephone and Telegraph Co. made October 10.

The new rate for a three-minute telephone conversation from New York to Hawaii will be $9 on weekdays and $7.50 at night and on Sundays. In the Hawaiian Islands calls are handled by the Mutual Telephone Co., while on these shores they are handled through the short wave radio telephone stations of the A. T. and T. Company near San Francisco. Telephone service to Hawaii, which was initially opened in December 1931, was the first extension of Bell System service toward the Far East. The original charge for a three-minute conversation between New York and Honolulu was $30.

Under the new rates, a three-minute telephone conversation between New York and Puerto Rico will cost $7.50 on weekdays and $6 at night and on Sundays. When radiotelephone service to this Caribbean Island was first opened in February 1936, the cost of a call from New York was $18. At the Puerto Rico end, the service is handled by the Radio Corporation of Puerto Rico, a subsidiary of the International Telephone & Telegraph Corporation.

Telephone calls between the States and Alaska are routed via Bell System lines to Seattle and then to Alaska over radiotelephone channels of the Alaska Communications System, a branch of the U.S. Army Signal Corps. With the cooperation of this branch of the Army, rates will be reduced so that a three-minute conversation from New York to Juneau will cost $7.50 for weekdays and $6 during the night and Sunday periods. To Nome, and to Adak in the Aleutians, the charges will be $9 and $7.50 for the corresponding periods.

### Super Duty Firebrick

The Mexico Refractories Co. announces the "Jay Bee Maximul" brand of Super Duty Firebrick to complete a trio of qualities of brick in the Super Refractories field. The "Jay Bee Fine" brand is recommended for furnace work where an all-round Super Duty Firebrick is required; "Jay Bee Coarse" where resistance to severe spalling is of prime importance and the "Jay Bee Maximul" brick are designed for use where very severe slagging and abrasive conditions are encountered.

The "Jay Bee Maximul" is a specially burned firebrick possessing unusual ability to withstand slag attack; it has maximum density, will not shrink in service nor deform under heavy loads. The tough, solid, rock-like body, resulting from high temperature burning in manufacture, gives to the brick a remarkable stability at high temperatures in service. It has a P.C.E. value of Cone 34 and meets all A.S.T.M. specifications for a Super Duty Firebrick, with a wide margin of safety. Stocks are carried in all principal cities; for complete details and prices write the Mexico Refractories Co., Better Refractories Building, Mexico, Mo.

### Air-Conditioned Trolley Coach

A significant "first" in modern urban transportation is the Carrier-equipped fully air-conditioned trolley coach, now under construction in Worcester, Mass., and soon to be delivered to the Georgia Power Co. for experimental use in Atlanta.

With all-weather comfort its keynote, the new coach, first of its type to be built exclusively for intra-city transportation, will maintain the appearance of the standard trolley-bus now in widespread use. The air-conditioning equipment, designed by and installed under the supervision of Carrier engineers, has a cooling and dehumidifying capacity equal to that used on latest design railway cars, and twice that required for inter-city busses. The reason for this large capacity is the high concentration of passenger load and frequent opening and closing of doors, according to Henry G. Strong, Director of Transportation Air Conditioning Sales of the Carrier Corp., Syracuse, N. Y.

The system consists of two Carrier air conditioning units and one Carrier Freon compressor. The compressor is driven by a 600-volt D. C. motor, receiving current from the trolley system. Two separate air-cooled condensers are used, each provided with fan and motor. Cooling capacity control is automatic. The driver can use the fans of the air conditioning units to provide ventilation without the use of the refrigeration machinery, if he so chooses.

Mounted over the roof of the coach, the air conditioning units are held by steel framing which carries the load to the side walls or posts. Cork pads isolate the unit from the frame, and there is no direct contact with the roof at any one point.

The compressor-motor assembly is mounted on a rigid structural steel frame, welded, and attached to the coach underframing members through vibration elimi-

Continued on Page 32

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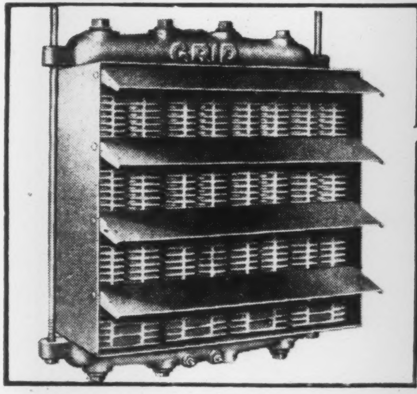

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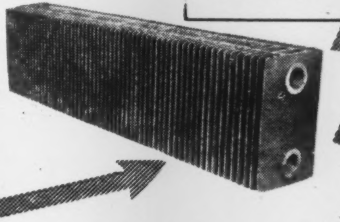

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NO SOLDERED, BRAZED WELDED OR EXPANDED CONNECTION

NOTHING TO BECOME LOOSE

- One piece construction heating sections (patented) of high test cast iron and will withstand steam pressures up to 250 lbs.
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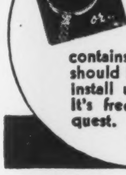
It's the material that makes a difference in GRID Unit Heaters. That's why they are free from maintenance expense. Many units in operation 15 years without any maintenance. Capacity tables upon request.



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New booklet "Corrosion in Unit Heaters" contains information you should know before you install unit heaters. It's free upon request. Send for it today.

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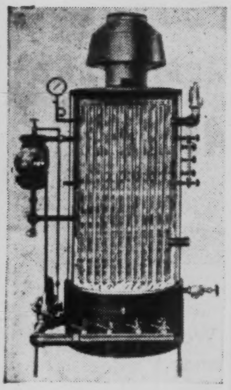
*the Kane Boiler*



When considering a boiler for future replacement of worn equipment or expansion of existing facilities, engineers should specify the scientifically designed KANE.

Gas-fired, automatic, the nationally accepted and economical KANE is built in sizes up to 30 H.P., to A.S.M.E. standards. Other advantages are—precise temperature control, cleanliness, minimum space requirements and long, trouble-free, service life.

Plan steam boiler requirements well in advance to be sure of a boiler when needed.

MEARS-KANE-OFELDT INC.
Manufacturers of Automatic Steam Boilers
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*A critical review of the literature covering the development of . . . .*

**RIVETED JOINTS**

*with bibliography and abstracts of the most important articles. . . .*

Besides being the answer to a long-felt need for a thorough study of the literature on Riveted Joints, this book makes accessible a wealth of information not generally known today on rivets, riveting (with respect to methods and practice), and riveted joints.

To make the coverage of the literature comprehensive the author, Mr. A. E. deJonge, has reviewed, abstracted, and indexed the important articles on the subject published in Australia, Austria, Canada, France, Germany, Great Britain, Holland, Italy, Japan, Russia, Sweden, Switzerland, Venezuela, and the United States from 1837 to 1944.

CONTENTS

**Foreword, Preface, Riveted Joints—A Critical Review of the Development, Bibliography and Abstracts from the Literature on Riveted Joints for the period from 1837–1940, Supplement of References for the period from 1940–1944, Name and Author Index, Subject Index.**

*Published 1945*

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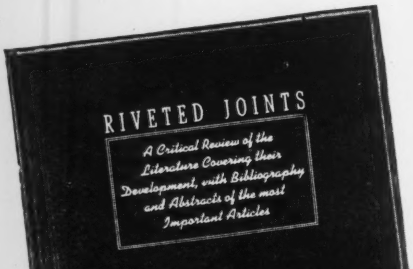


RIVETED JOINTS

*A Critical Review of the Literature Covering their Development, with Bibliography and Abstracts of the most Important Articles*

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
*Publication Sales Dept.*
29 West 39th St., New York 18, N. Y.

## • Keep Informed

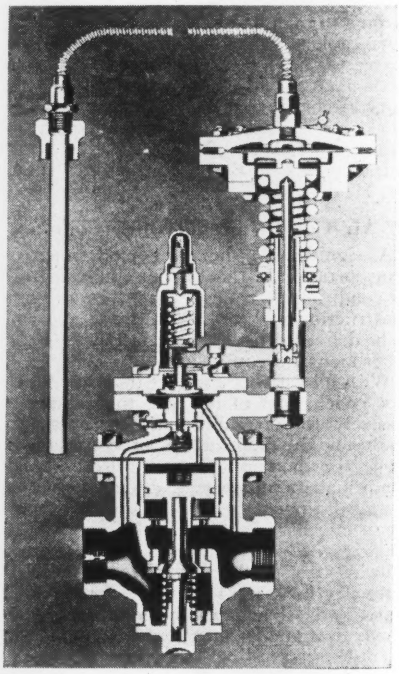
nators. The assembly is protected from splash by a sheet metal housing which covers the bottom and sides. Air is forced through this enclosure, entering a louvred opening at the motor end and escaping along the sides and at the compressor end. This air flow is set up by the forward motion of the coach.

Ducts passing down both sides of the coach at the ceiling distribute the air through perforations at the rate of 800 cubic feet per minute, while the fans circulate a total of 2,200 cubic feet through the coach.

Electric motor requirements for the complete installation include a 10 h. p. on the refrigeration compressor, two one h. p. fans for pulling the air through the refrigeration condensing coils, and two one-half h. p. fans for circulating the air through the cooling and dehumidifying coils and filters and for drawing in the outside air.

### Leslie Announces Temperature Regulator With Duo-Matic Control

A self-contained, spring loaded, internal pilot, piston operated Temperature Regulator for steam service, has been announced by Leslie Co., 287 Grant Avenue, Lyndhurst, N. J. makers of regulators, controllers and whistles.



A prominent feature of the new Regulator is Duo-Matic Control, whereby both accurate temperature regulation and pressure control are obtained simultaneously with a single regulator. Piping is thus simplified and installation costs materially reduced.

The new Regulator has a wide range, rugged thermostatic element with 100°F. adjustable temperature range. It is single-seated for positive dead-end control. It is equipped with metal diaphragms, has no bellows or packing glands. Leaks are eliminated and minimum attention is required.

All wearing parts are renewable. 100% interchangeability allows complete overhaul without removal from the pipe line. Corrosion and wear resistance is obtained with the use of stainless steel hardened wearing parts. Vital parts are hardened to at least 500 Brinell.

A vapor filled thermostatic element acting through the upper diaphragm and lever opposes pressure limit spring and determines the steam pressure delivered by regulator to heat exchanger. Manual compression of the limit spring determines maximum outlet pressure and opens controlling valve admitting high pressure steam from inlet body port to top of piston which opens main valve. The outlet steam pressure acting under steam diaphragm balances compression of limit spring, throttling controlling valve and limiting the maximum outlet pressure.

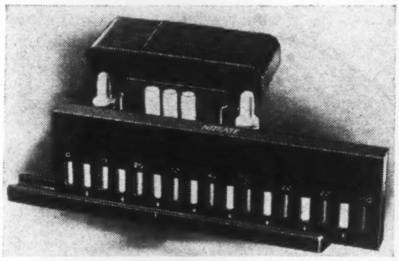
The temperature at which the vapor pressure starts to oppose the limit spring and decrease outlet steam pressure is set on the adjusting spring. This spring opposes the vapor pressure through the large upper diaphragm and by means of this spring the temperature, at which all steam to heater will be shut off, can be accurately set.

A temperature drop of 1°F. at bulb reduces vapor pressure, allowing limit spring to open controlling valve and deliver an increased steam pressure to heat exchanger.

Therefore, outlet steam pressure is always directly proportional to the change in temperature at bulb and this pressure is automatically maintained regardless of the volume of steam used by heater or variations in supply pressure.

### Nitrate Comparator

W. H. & L. D. Betz, Philadelphia 24 and W. A. Taylor & Co., Baltimore 4 have jointly developed a simple accurate test for the nitrate ion in boiler water. The test procedure was established in the laboratory of W. H. & L. D. Betz and the equipment designed by W. A. Taylor & Co.



The Taylor-Betz Nitrate Comparator finds particular application in routine plant control of the Nitrate/Hydroxide ratio in boiler waters for the prevention of embrittlement. The equipment consists of a comparator base and slide covering the range 0 to 100 p.p.m. nitrate in nine gradations. An initial supply of reagents is furnished with the comparator. The accuracy of the method is not affected by ions normally present in boiler water. Complete information can be furnished by W. H. & L. D. Betz or W. A. Taylor & Co.

### Electricity Supplied to Belgium by U. S. Floating Power Plant

One of America's floating power plants, which would look more at home on the Mississippi and was intended for waterways like that in the first place, has just been disclosed in the role of an ocean voyager that beat out a 51-day crossing of the Atlantic to generate part of Belgium's electric power after the Allies had liberated that country.

The queer looking craft, appropriately named the "Resistance," is capable of supplying the electric power needs of a city of 100,000, and is one of the floating power plants built to meet temporary power shortages expected in the U.S.A. in the early stages of the war production program.

How the "Resistance" was taken to Antwerp and hooked into the Belgium power system is told by her executive officer,

Continued on Page 35

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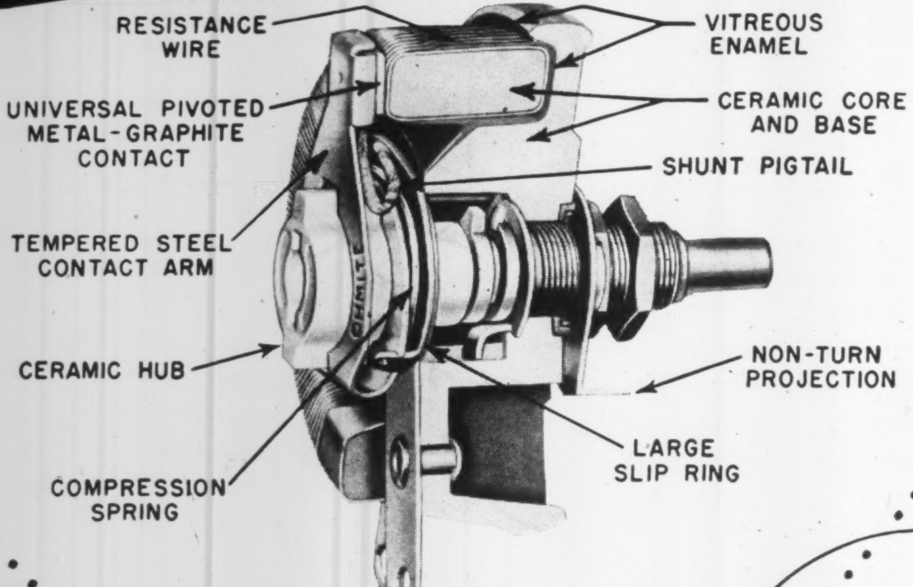
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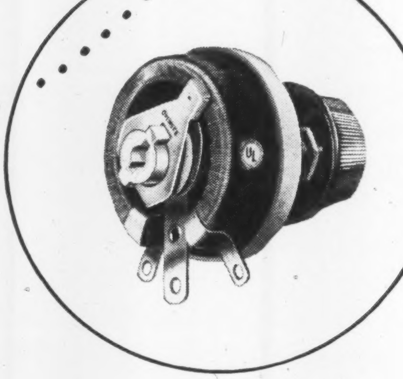

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**RHEOSTATS • RESISTORS • TAP SWITCHES**

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Capt. George W. Franks, in "The Maintenance Engineer," a publication of the Corps of Engineers, U.S. Army.

Captain Franks reports that the Transportation Corps towed the "Resistance," the Navy convoyed her over, and the Engineers manned her on the trip and after she was put in operation. The 3-knot-per-hour trip was comparatively quiet, but as the convoy hit the Scheldt estuary, German E-Boats moved in for the kill. Escorting craft took up the fight and destroyed the attackers after a duel of tracers and shells had lighted up the pitch-black night for some hours. During the months that the "Resistance" lay in Antwerp pumping juice into the lines, the Germans tried to destroy the port with 2600 V-bombs. Only one came close enough to shake up the old girl, however, and then not seriously.

The plant is housed in a steel hull half a city block long. Power is generated by a General Electric hydrogen-cooled generator driven by a steam turbine. Steam is supplied to the turbine by two oil-fired boilers that can consume a half-million gallons of fuel oil in about seven days. The power lines were directly connected to the Belgium power lines in the Amsterdam hook-up by means of a 20-ft transmission tower built on deck.

Communications throughout the plant are made by telephones connecting the office and the CO's quarters with the main operating stations throughout the plant. In addition to the power-generating equipment on the barge, there is a machine shop equipped with lathes, grinders, pipefitting equipment, blacksmithing equipment, rigging, tinsmithing, and arc and acetylene welding equipment.

The plant operates four shifts and carries its own medic and has its own hospital. There are galley and mess accommodations. Quarters are provided for the regular crew with additional bunk space for the Merchant Marine crew that "sailed" her on the Atlantic trip.

Fire-fighting equipment consists of a battery of 76 cylinders of $CO_2$ piped throughout the plant. The fire-fighting chemical can be released from any of several control stations located at various places in the plant. In addition, above and below decks are high-pressure water hose connections supplied by the fire pumps.

Widespread attention was created in Belgium by the "Resistance." She was visited by high-ranking American and British Army officers and scores of Belgian electrical engineers and university students.

### More Light on Dust

To the highly versatile electron microscope has been added still another important function: the determination of the size, distribution, and shape of infinitesimal particles of dust and pollen in the air. A subject of considerable interest to the air-cleaning industries, the study of these particles has been limited by the magnifying power of the light microscope, which can give information only on particles above five microns in size (about two ten thousandths of an inch.)

But the electron microscope, with its magnification of up to 50,000 diameters, can recognize particles as small as 0.005 micron, and can determine the form of those 0.02 micron or larger. Doctors E. A. Gulbransen and R. T. Phelps of the Westinghouse Research Laboratories are making such studies on particles of dust, tobacco smoke, and pollen, collected from smoggy, rainy, and clear atmospheres.

*Continued on Page 36*

MODERN VALVES
FOR *MODERN* EQUIPMENT

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The Clayton "Feather-Touch" Pilot and the Clayton Remote Control Valve are the *modern* combination for all types of installations and equipment where valves must be opened and closed automatically or manually by remote control.

**MANUAL OPERATION**
A single Clayton "Feather-Touch" Pilot opens and closes single valves... or groups of valves...individually or simultaneously. The touch of a finger on the Selector Pointer of the Dial does the job...with any line pressure to 300 P.S.I.

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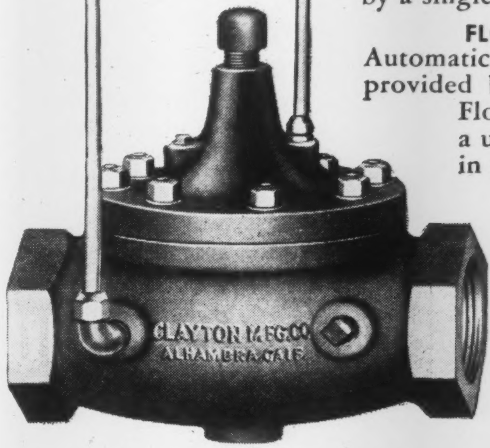
Automatic electrical control is provided by means of the Clayton Solenoid Pilot. Single valves...or groups of valves...can be operated by a single Clayton Solenoid Pilot.

**FLOAT MECHANISMS**
Automatic Liquid Level Control is provided by means of the Clayton Float Mechanism...either as a unit with Clayton Valves or in remote installations in connection with any kind of tank or sump. Clayton Float Control Equipment is also available for valve operation on Separator Units handling liquids of varying specific gravity.



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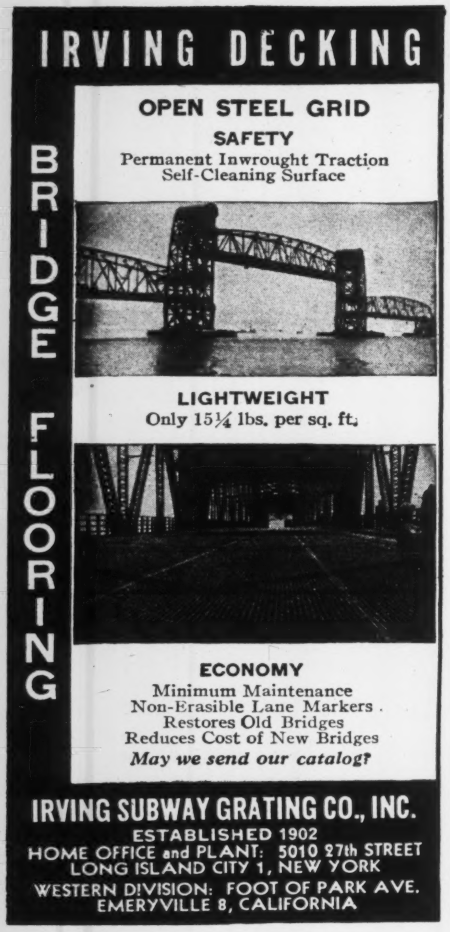

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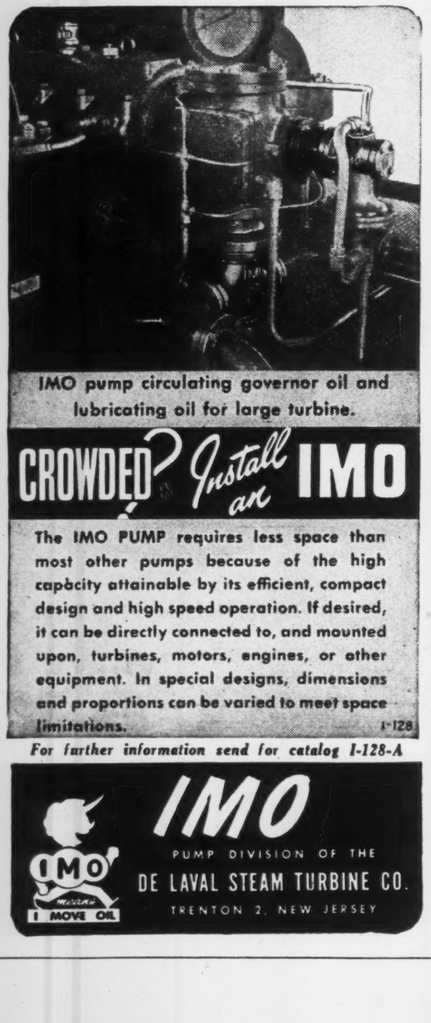

IMO pump circulating governor oil and lubricating oil for large turbine.

CROWDED? Install an IMO

The IMO PUMP requires less space than most other pumps because of the high capacity attainable by its efficient, compact design and high speed operation. If desired, it can be directly connected to, and mounted upon, turbines, motors, engines, or other equipment. In special designs, dimensions and proportions can be varied to meet space limitations. I-128

*For further information send for catalog I-128-A*

IMO
IMO MEANS I MOVE OIL
PUMP DIVISION OF THE
DE LAVAL STEAM TURBINE CO.
TRENTON 2, NEW JERSEY

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Because the electron microscope can penetrate matter to a depth of only 0.01 to 0.05 micron, the specimens must be collected on an extremely thin film of collodion or other plastic material. This in turn is mounted on a 200-mesh stainless-steel screen $^1/_8$ inch in diameter. Tobacco-smoke particles can be collected by holding the film and screen in a trail of smoke for a few seconds. Dust can be gathered electrostatically by making the specimen the negative electrode and a fine point the positive electrode. A large collection of dust, smoke, or pollen can either be dusted on the screen or film, or dispersed in water and a drop evaporated on the screen.

The studies Dr. Gulbransen and Dr. Phelps have made so far show the effectiveness of the electron microscope in studying air-cleaning problems. Not only can the nature of the foreign material in the air be studied, but also the efficiency of the air-cleaning process itself can be evaluated.

### "Electromet" Manganese Metal Prices Reduced

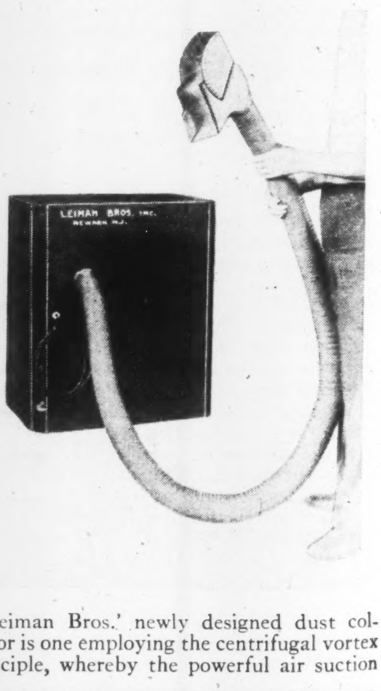
A reduction of four cents a pound in the maximum 2.00 per cent iron grade of "Electromet" manganese metal, effective September 1, 1945, has been announced by Electro Metallurgical Sales Corporation, Unit of Union Carbide and Carbon Corporation. The maximum 2.50 per cent iron grade will be discontinued and all shipments of "Electromet" manganese metal will now conform to the following high-quality specification:

| | | |
|---|---|---|
| Manganese | 96.00% | minimum |
| Silicon | 1.00% | maximum |
| Carbon | 0.20% | maximum |
| Iron | 2.00% | maximum |

All users of "Electromet" manganese metal will now obtain the same or a higher-quality material at a lower price. Adequate stocks are available for prompt shipment. Inquiries should be addressed to Electro Metallurgical Sales Corp., 30 East 42nd Street, New York 17, New York.

### A Dust Collector May Save Your Life

Daily breathing of irritating dust particles often results in tuberculosis, pneumoniocosis, fibrosis of the lungs, hard coughs and weakening colds—all causing losses in time and earning capacity.



Leiman Bros.' newly designed dust collector is one employing the centrifugal vortex principle, whereby the powerful air suction

## • Keep Informed

draws the dust through the flexible hose and hood provided and into the interior of the cabinet, which contains a circular, conical shaped cyclone tank.

The rapid spinning of the air forces the dust particles to the centre of this mass of spinning air, and its gravity drops it to the bottom and into a dust receptacle, where it may be quickly and easily removed.

As the centre of this whirling mass of air is almost pure dust, the outer edge of the mass is almost pure air separated from the dust—and being rid of the dust and consequently being that much lighter, it floats out through the fine fiberglass filter top of the cabinet and is free to recirculate into the air of the room.

By using this much more costly system of separation, the use of dust bags as primary air strainers is eliminated—at the same time the method of manufacturing these outfits has resulted in no increase in the price to the user.

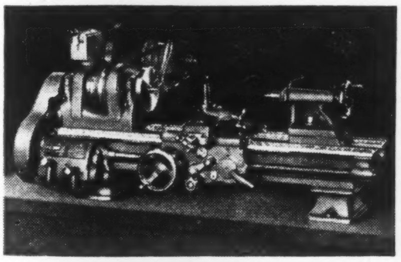
Everyone who grinds or buffs or is in any way connected with a shop where such work is done on grinding machines, including surface and universal grinders, on single or double wheel grinders or buffers, circular or band saws or sanding wheels or belts, etc., will be interested in this great safeguard for his own health and that of others in his shop.

Remember it doesn't cost much to prevent the deleterious effect of dust breathing, but it does cost a great deal to counteract or cure these effects if indeed it is caught in time.

Free information will be gladly furnished if you will drop card or letter to Leiman Bros., 118-80 Christie St., Newark 5, N. J.

### New South Bend V-Belt 9" Lathe

Latest addition to the South Bend Lathe Works' line is a V-belt Drive 9" Precision Bench Lathe which is illustrated and described for the first time in their Catalog 9-G, just off the press.



Made especially for those who prefer the several advantages of the V-belt drive, this bench lathe features 4-step, V-belt cone pulleys which, with the back gears, provide either 8 or 16 spindle speeds ranging from 46 to 1176 r.p.m. It is made with either quick-change gear or plain change gear equipment for a wide range of thread cutting and power longitudinal feeds. Two of the models incorporate power cross-feeds.

All models have a 9-1/4" swing over the bed and saddle wings, and 3/4" headstock spindle hole with maximum collet capacity of 1/2". Choice of bed lengths give maximum distances between centers up to 34". The usual line of practical South Bend Attachments is available for special classes of work.

This lathe is ideal for precision toolroom or production work, and for general use in machine, laboratory, and repair shops for machining metals, plastics, compositions, and other machinable materials.

Complete, detailed information on this model can be obtained by writing to the South Bend Lathe Works, 385 E. Madison St., South Bend 22, Ind.

*Continued on Page 38*

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Improve PRODUCTION PROCESSES and cut costs with KENNAMETAL SPECIAL TOOLS
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PRESSING DIE AND RAM
DIE FILE
BALLS FOR SIZING
WIRE ROPE DIES
FLARING TOOLS
CHUCK JAWS

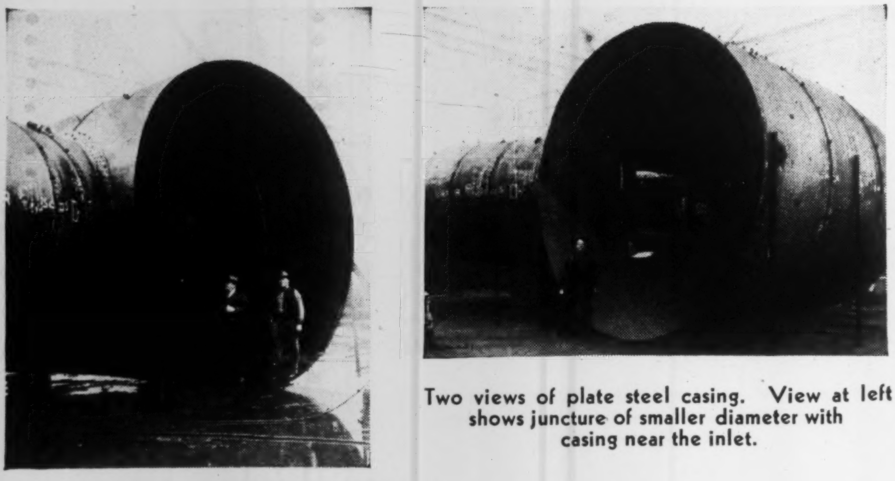
The properties that make Kennametal outstanding for fast, economical machining of steel, cast iron, non-ferrous metals, and non-metallics, are equally useful when applied to a variety of other production processes. Shown on this page are a few examples that suggest scores of economic applications of Kennametal on special tools, dies, and rolls.

Kennametal is the tough, strong, cemented carbide that contains an extremely hard intermetallic compound, $WTiC_2$. Its superior wear-resistance comes from a combination of precisely maintained properties—high modulus of elasticity (2 to 3 times that of steel); low coefficient of friction; and exceptional hardness (up to 92.3 on Rockwell A scale).

Kennametal can be accurately molded into almost any shape, limited only by reasonable proportions. Its cost is moderate—almost insignificant when compared with the tool and production economies effected through its use. The best way to prove this is to let us cooperate with you in designing a Kennametal tool for test purposes on your specific job.

*Remember, Kennametal can be used in your production machines without entering into any complicated, continuing agreements.*

KENNAMETAL
SUPERIOR CEMENTED CARBIDES
KENNAMETAL *Inc.*, LATROBE, PA.



Two views of plate steel casing. View at left shows juncture of smaller diameter with casing near the inlet.

ANOTHER BIG JOB . . . BY DOWNINGTOWN

Large fabrication jobs like this casing . . . 17′—4¾″ diameter at open end . . . involving intricate developments . . . exacting pressing and end forming operations, are constantly going through our shops.

Over thirty consecutive years' experience; adequate modern facilities; built-in quality; careful selection of materials; rugged construction; the consultation of a nationally known metallurgical authority,—all insure the complete satisfaction of the customer.

Let us plan with you on your next job . . . even out-of-the ordinary fabrications are routine to Downingtown. Whether steel, chrome, chrome-nickel, monel, nickel or stainless and alloy clad steel are specified, our engineers will advise you if we can do the work economically and satisfactorily.

For further details send for the "Fabrication Book."

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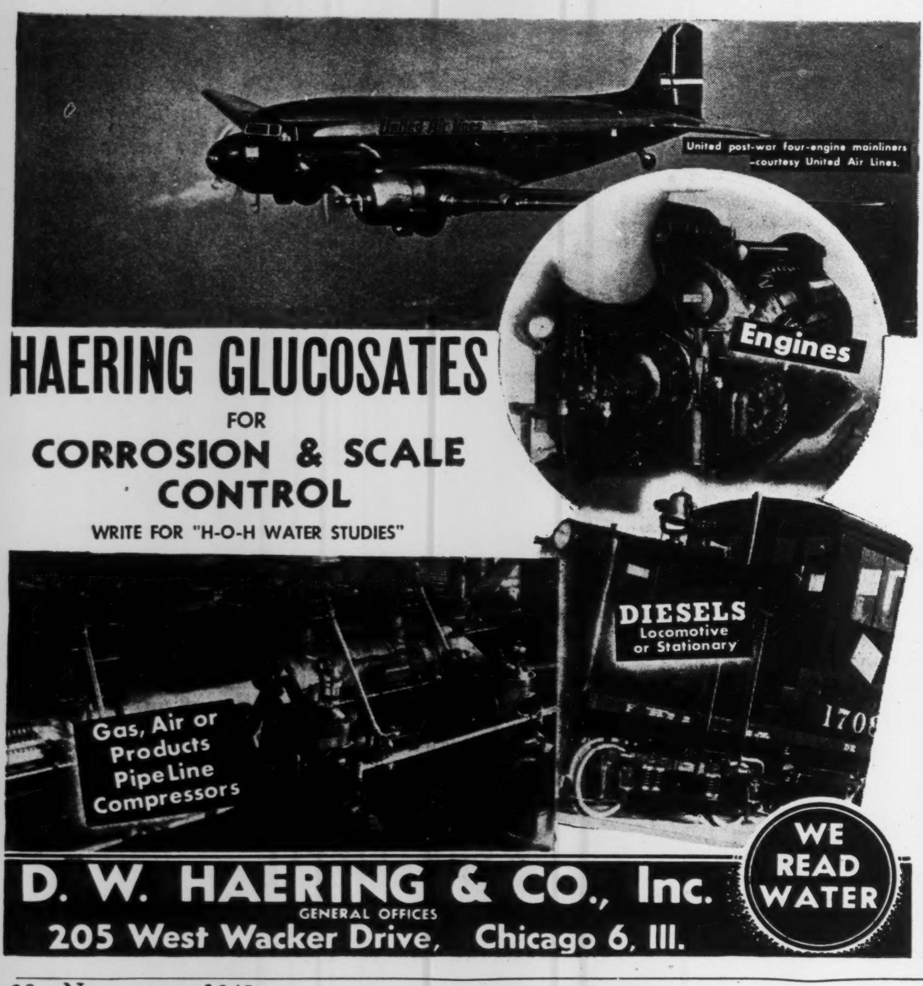

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### Engineer Wins Highest Award

The Order of Merit, highest honor bestowed on its employes by the Westinghouse Electric Corp., has been presented to Edwin L. Harder, central station engineer in the Industry Engineering Department of the Company's East Pittsburgh Works.

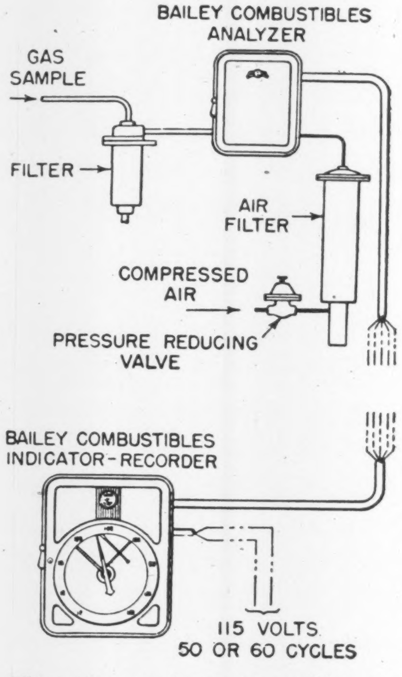
Mr. Harder is the author of numerous engineering papers and holds approximately 40 patents, largely in the relay and control field. He is a past chairman of the Relay Subcommittee of the Protective Devices Committee of the American Institute of Electrical Engineers. He lives at 1204 Milton Avenue in Regent Square, Swissvale, Pa.

The citation accompanying Mr. Harder's award reads: "for his ability to analyze the requirements of power system protection and to make suggestions by which they may be satisfied, for his clarity in presenting network theorems to the engineering profession, and for the confidence and esteem inspired in the central station industry by his sound engineering recommendations."

A native of Buffalo, New York, Mr. Harder attended Lafayette High School in that city, was graduated from Cornell University with an electrical engineering degree, and received his Master of Science degree in the same field from the University of Pittsburgh. Joining Westinghouse in 1926, he worked in the Power Engineering Department, the General Engineering Department, the Switchgear Engineering Department, and is now in the central station group of the Industry Engineering Department, having the assignment of Central Station Engineer for the Middle Atlantic District.

### Combustibles Recorder-Controller

A new automatic analyzer and recorder for indicating, recording and controlling the combustibles content of a gaseous mixture, has been developed by the Bailey Meter Co., Cleveland 10, Ohio. This instrument has been successfully applied to precision control of furnace atmospheres and chemical processes, as well as combustibles measurements in the petroleum, metallurgical, automotive, and chemical industries.


BAILEY COMBUSTIBLES ANALYZER
GAS SAMPLE
FILTER
AIR FILTER
COMPRESSED AIR
PRESSURE REDUCING VALVE
BAILEY COMBUSTIBLES INDICATOR-RECORDER
115 VOLTS 50 OR 60 CYCLES

The analyzer and recorder provide a continuous graphic analysis almost instantly,

## • Keep Informed

and they are said to be responsive to changes of .05% combustibles. Sustained accuracy is said to be within .25%.

A continuous gas sample is mixed with compressed air and burned on a catalyst-filament which reaches a temperature proportional to the combustibles content. Since the filament resistance is a function of temperature, a simple resistance bridge connected to a null-balance electronic recorder completes the installation. It may be calibrated in per cent combustibles, mixture ratio, or other desired terms.

Pneumatic control or electric alarm contacts may be provided on both one and two-pen recorders. A two-pen recorder utilizes separate analyzers so that the speed is not impaired by switching, and the two records are independent of each other.

Combustibles Recorder-Controllers applied to process furnaces operating with reducing atmospheres are said to permit finer measurement and control than has heretofore been considered possible. This results in greater uniformity and higher quality of product, as well as greatly increased furnace economy. Variable fuel quality does not affect the accuracy of control on installations of this type.

Plants in the chemical industries, as well as other operations having processes where gases contain combustibles, find the continuous graphic analysis of this recorder to be a valuable addition to their instrumentation.

## • BUSINESS CHANGES

### Olson, Jr., Is Brown Stockholm Manager

Sigfried A. Olson, Jr., has been named industrial manager at Stockholm, Sweden, for the Brown Instrument Co., Philadelphia division of Minneapolis-Honeywell Regulator Co. Olson has been New York sales engineer for the Brown company for the past nine years. He is thoroughly experienced in all the new electronic and standard instrument applications. He will report at Stockholm upon completion of necessary transportation clearance.

### Two New Trimount Representatives

Trimount Instrument Co., 37 W. Van Buren Street, Chicago 5, manufacturers of manometers, liquid level gauges, flow meters, electronic level controls, dynamics measurement equipment and allied products, has appointed two new sales representatives for the Pittsburgh and Detroit areas.

M. N. Weber, formerly of Continental Aviation and Engineering Corp. research laboratories, Detroit, Michigan, will represent Trimount in the Detroit area. His offices are at 2450 Hubbard Street, Detroit.

M. S. Jacobs, formerly instrument engineer of The Koppers Co., Pittsburgh, Pa., represents the company in the Pittsburgh area. Offices are in the Bessemer Bldg.

### Bailey Meter Sales Executives

The appointment of W. E. Dueringer as Assistant Sales Manager and H. E. Weaver as Proposition Department Manager has been announced by H. M. Hammond, General Sales Manager of Bailey Meter Co., Cleveland 10, Ohio.

Both Mr. Dueringer, who is a graduate of the University of Illinois and Mr. Weaver, who is a graduate of Johns Hopkins University, have been associated with Bailey Meter Company for over 25 years in various engineering and sales capacities. During this

*Continued on Page 40*

**Dependable Water Supply For America's Railroads**

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### Lincoln Electric Opens New Office

Cleveland, Ohio. The Lincoln Electric Co., world's largest manufacturers of arc welding equipment, announces the opening of a direct factory branch sales office in St. Louis. The new branch, under the direction of B. J. Brugge as Welding Engineer and District Manager of Sales and Service, will be located at 4427 Manchester Avenue, with telephone number Newsteak 6516.

Mr. Brugge has been associated with The Lincoln Electric Co. since 1931. He is a graduate of Purdue University and began his career in arc welding with two years in research laboratories of the company. In 1935 he was granted a leave of absence to assist in the application of electric welding in the Near East. Serving in the capacity of welding superintendent for the Anglo-Iranian Oil Company, he spent two years at Iran, Persia, supervising welding operations in the construction of refineries and pipe lines. He directed the training of many Persians in the art of welding and increased the Anglo-Iranian Company's welding forces from 30 to 120 arc welders.

Following his work in Persian oil fields, Mr. Brugge spent four months in the British Isles as welding consulting engineer for British and Scottish firms.

During the early years of the war, Mr. Brugge re-designed and constructed the Army's first all welded medium tank at Rock Island Arsenal and helped develop armor plate welding, working with the Army Ordnance at the Aberdeen Proving Grounds. He has also assisted the Navy and Maritime Commission with consulting services on shipwelding.

For the past year Mr. Brugge has served The Lincoln Electric Co. in the Detroit area in assisting firms in the design and fabrication of both war and post-war products.

### Republic Flow Meters Appoints Drescher

Rowland B. Drescher has been appointed manager of the Pittsburgh district, for the Republic Flow Meters Co., with offices in the Investment Building. He succeeds Carl E. Pritchett who died on April 12th after managing that district for twenty-three years.

Mr. Drescher is a mechnical engineering graduate of Renssalaer Polytechnic Institute and had considerable engineering and power plant operating experience before joining Republic. His promotion from Republic's contract engineering department comes after eight years of engineering a great variety of applications of Republic combustion control, regulators, reducing valves, desuperheaters and instruments.

### Fairbanks, Morse & Co. Announces Two Sales Executive Changes

Two changes in the sales executive organization of Fairbanks, Morse & Co. have just been announced by Robert H. Morse, Jr., Vice President and General Sales Manager.

New acting manager of the Railroad Division is John S. King, formerly manager of the company's Pump Division. He succeeds C. H. Wilson, who is on an extended leave of absence due to his health.

Arnold G. Brown, formerly assistant manager of the Pump Division, succeeds Mr. King as manager of that Division.

Mr. King is a veteran in the Fairbanks-Morse organization. He started as a student in the Beloit plant where he assembled and tested pumping equipment and Diesel engines. In 1921 he was transferred to the Indianapolis plant, a year later became territorial representative of the Pump Department in Chicago, and in 1930 was made Pump Department Manager of the Chicago Branch.

In 1937 Mr. King was appointed Manager of the New Orleans Branch and last spring was made Manager of the company's Pump Division.

Mr. Brown was general sales manager of the Pomona Pump Co., when it was purchased a year ago by Fairbanks, Morse, & Co. Soon afterwards he was made assistant manager of the Pump Division. A graduate engineer of the University of Syracuse in 1929, Mr. Brown traveled extensively as an engineer until 1937 when he went with the Pomona Pump Co. as a junior engineer in

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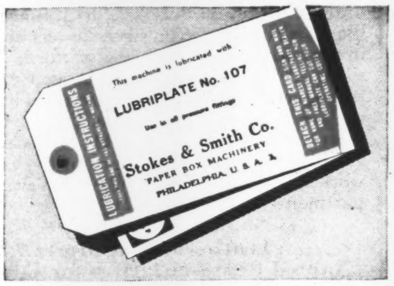

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3. A return postcard is part of each tag. The machine buyer signs the tag and mails it to us.
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OUR 75TH YEAR
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DEALERS FROM COAST TO COAST

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the sales engineering department. Later he became the firm's Southeastern manager, and at the beginning of the war was moved to New York and Philadelphia where he was in charge of the firm's government procurement contracts. In 1943 he was appointed assistant sales manager and just before the firm was purchased by Fairbanks-Morse was made General Sales Manager.

Mr. Wilson has been in charge of railroad sales for Fairbanks-Morse since 1932. Except for four years—two of which were spent as a lieutenant of engineers in the first world war—he has been with the company since 1905. "Charley", as he is known in the trade, has a host of friends who wish him a speedy recovery, and a quick return to his job.

### W. D. Turnbull Appointed General Sales Manager of Kennametal

Kennametal Inc., of Latrobe, Pa., has appointed W. D. Turnbull as General Sales Manager. The Company plans to increase its present activity in the metal-working industry, and also to extend the application of Kennametal to other fields, such as mining, petroleum, and wood-working. Efficient and durable tools for cutting, drilling, and forming, have been developed for use by these industries. Mr. Turnbull, a graduate Electrical Engineer from Pennsylvania State College, has had more than 25 years of broad and successful experience in both engineering and sales of products used in diversified industries, and is holder of the Westinghouse Electric Corp.'s Award of Merit for outstanding work in these fields.

With that organization he successively filled such positions as: Manager of Mining and Petroleum Sales and Engineering; Manager of the Agency and Specialties Department, having to do with the distribution and sale of such products as welding apparatus and X-Ray equipment; and Manager of the Machinery Electrification Department, involving the application and sales of electrical equipment to the machine tool and other heavy machinery industries.

For four years he was Vice President in Charge of Sales for Pomona Pump Co., of Pomona, California.

He has been closely associated with the mining industry in the design and application of equipment, as well as in the adoption of standardization and safety practices. While with Westinghouse he started the Machine Tool Forum, which has become one of the Industry's most important meetings.

### Twin Disc Names Adamson Vice President; Other Personnel Changes Are Announced

The election of N. F. Adamson as vice president in charge of sales and engineering of the Twin Disc Clutch Co., Racine, Wisconsin, has been announced by P. H. Batten, president of the company.

Mr. Batten also announced the following additional personnel changes:

E. C. Billings has been named sales manager of the Racine division.

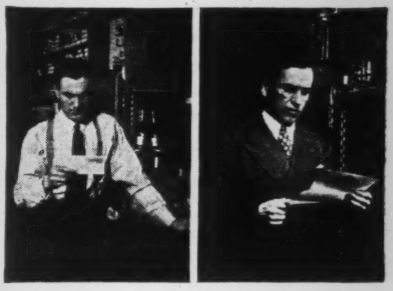
Roger G. DeLong has been appointed sales manager of the hydraulic division, with headquarters at the company's Rockford, Illinois, plant.

G. W. Buelke has been appointed chief engineer of the Racine division.

The purpose of the new appointments, according to Mr. Batten, is to provide a closer coordination of engineering, sales and service activities in the Racine and Rockford divisions, and to make closer contact possible between the main offices and users of Twin Disc

*Continued on Page 42*

LUBRICATION SERVICE FOR MACHINERY USERS



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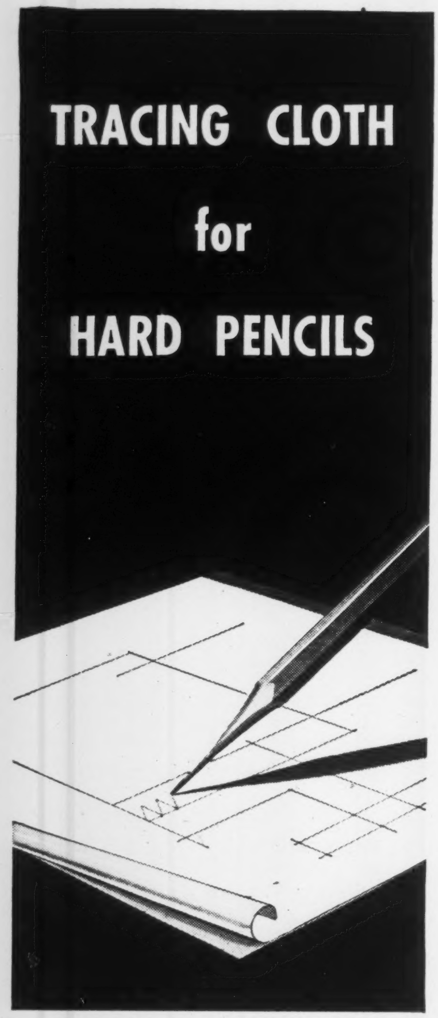

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Clutches and Hydraulic Drives, supplementing the regular contacts made by personnel of the company's district offices.

Manufacture of the company's extensive line of friction clutches, air clutches and marine gears is centered in the Racine division, where the home office is located. Hydraulic torque converters, hydraulic couplings and hydraulic power take-offs are built in the hydraulic division at Rockford.

Mr. Adamson, who has been general sales manager for the past two years, has been associated with the Twin Disc Clutch Co. for more than two decades. He was chief engineer for many years, and prior to that time worked with the sales and engineering departments.

### Leatherman & Mertz Named Representatives for Edward in Detroit

Effective September 1, 1945, The Edward Valve & Mfg. Co., Inc., East Chicago, Ind., has appointed Leatherman & Mertz as its representatives for all of Michigan, excluding the upper peninsula.

The firm of Leatherman & Mertz is headed by Lloyd R. Leatherman and Charles M. Mertz. Offices are in the Book Building, Detroit 26, Michigan.

Leatherman, for 20 years a sales and service engineer in the power specialty field in Detroit, is a former power plant operator. Mertz, a graduate mechanical engineer from Penn State college, has been associated with a large boiler company in its Detroit office for 15 years.

"The Leatherman and Mertz organization is well staffed and well equipped to serve Edward users in the Michigan territory," W. F. Crawford, President of the Edward company, said in announcing the appointment. "Steel valve users can refer installation and service inquiries to them with confidence."

### Westinghouse Names Welding Specialist for San Francisco Bay Area

Edgar W. Bartz, formerly of East Pittsburgh and Trafford, Pa., has been appointed welding specialist for the San Francisco Bay area by the Westinghouse Electric Corp. Announcement of the appointment was made in San Francisco by Frank E. Bodine, San Francisco manager.

In his new post, Mr. Bartz will have charge of all Westinghouse activities having to do with the promotion and use of electric welding in the San Francisco Bay area.

VICTORY
LOAN

## • Keep Informed

A native of Phillips, Neb., Mr. Bartz joined Westinghouse at East Pittsburgh, Pa., in mid-1929 as a junior technical student. From early 1931 until late the following year, he worked in the company's Switchgear Division there. He resigned to go into business for himself in late 1932, and rejoined Westinghouse in early 1935 as a laboratory assistant in the company's Motor Division. In 1938 he was transferred to the company's plant at Trafford, Pa., to specialize in electric welding electrodes and materials. He served at Trafford until his recent transfer to San Francisco.

### Federal Products Texas Representative

E. L. Stacy, southern Texas representative for Federal Products Corp., manufacturers of Dial Indicators and Dial Indicator Gages, including Foote, Pierson Electronic Gage, and the Federal Metricator Air Gage; all for inspecting linear dimensions, has located in permanent office at 718 Leeland Avenue, Houston 2, Texas. Previously he had been doing business from his home located at 2148 Dryden Road, Houston 5, Texas, because of inability to find office space.

### Gegenheimer Returns to Timken Roller Bearing Co.

L. H. Gegenheimer, after a four-year leave of absence for war duties in Washington, is back with The Timken Roller Bearing Co., Canton, Ohio, in his former capacity as sales engineer in the industrial division.

Gegenheimer, a native of Vermilion, Ohio, was first loaned by the Timken Co. to the British Ministry of Supply, where he was supply officer until December, 1943; after which he became a dollar-a-year man with the War Production Board. When he left the War Production Board, he had become Chief of the Bearing Branch of the Tools Division, a post formerly held by Howard C. Sauer, another Timken employee, now head of Timken's foreign division.

In acknowledging Gegenheimer's resignation, John S. Chafee, director of WPB's Equipment Bureau, wrote to William E. Umstattd, Timken President:

"I want again to thank you and The Timken Roller Bearing Co. for the very generous and important contribution you made to the Tools Division of the Board by lending it such competent people. Your company was outstanding in the support given the work here."

Joining the Timken Company in 1935, following his graduation with a Bachelor of Science degree in Mechanical Engineering from Case School of Applied Sciences the preceding year, Gegenheimer spent a year in Canton as an engineer before being assigned to the Boston branch of the Timken firm in 1936. He is awaiting reassignment in the field now.

He is married and the father of two children: William 5; and Ann, $2^1/_2$ years old.

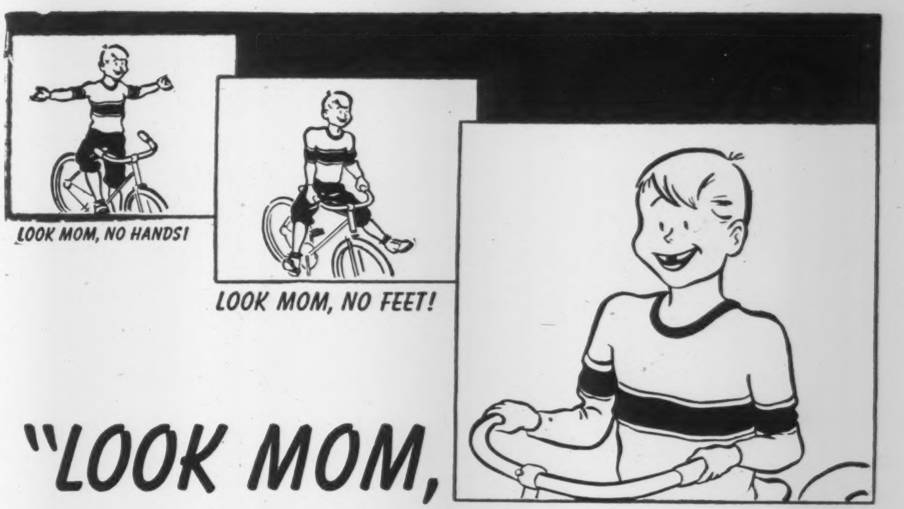
### Ponzio Appointed Sales Manager

Standard Heater & Oil Equipment Co., 245 Cornelism Ave., Jersey City 2, N.J. announces the appointment of Louis D. Ponzio as Sales Manager. Mr. Ponzio was formerly with leading manufacturers of heat transfer equipment. He is a graduate of Mechanical Engineering and also a licensed professional engineer in the state of New York.

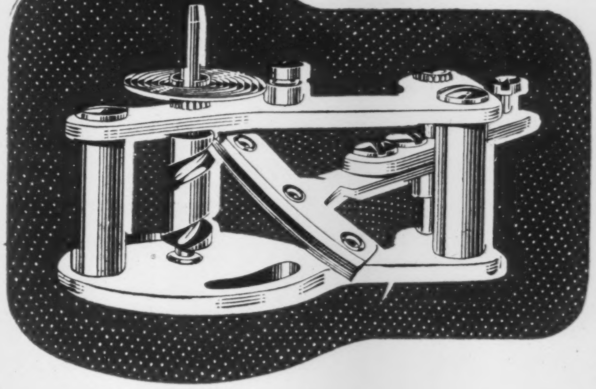
### La-Del Mfg. Co. Announces Appointment of New Plant Manager

Preliminary details of the peacetime production plans of the La-Del Conveyor &

Continued on Page 44


LOOK MOM, NO HANDS!
LOOK MOM, NO FEET!

"LOOK MOM, NO TEETH!"



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Manufacturing Co., New Philadelphia, Ohio, follow announcement of the appointment of Fred W. Blaisdell as Plant Manager. Mr. Blaisdell, who already has taken over his new duties, is well-known in Chicago industrial circles, having served in various production and personnel capacities in that area.

Coincident with word of Blaisdell's appointment, La-Del made it known that the company is embarking on a full-scale peacetime production highlighted by the coal mining equipment division, which has already marked up a 100% increase in production. This division is further preparing to begin manufacture of the new coal mining machinery to supplement the line of La-Del conveyors and ventilating equipment.

Important announcements concerning new advancements and developments in the axial flow fan field are expected shortly from the Fan Division of the La-Del Co. Although the output of the Fan Division was devoted 100% to Navy orders, La-Del, pioneers of the axial flow fan, has continued research work and is preparing new models for industrial, mining and domestic use. Production of the new models is expected to get underway in the very near future.

### Westinghouse Announces Purchase of Pennsylvania Plant

The Westinghouse Electric Corp., Pittsburgh, Pa., announced it would purchase property and buildings in Meadville, Pa., for the production of industrial heating equipment.

"The property, comprising more than five acres of land and five major buildings with more than 100,000 feet of floor space, is being purchased from Talon, Inc., after the boards of directors of both companies approved the sale this week," said L. B. McCully, manager of the Westinghouse Transportation and Generator Division.

"The entire Westinghouse line of industrial heating equipment will be produced in the Meadville plant," Mr. McCully declared. "This includes many types of furnaces and other devices for heat-treating, driers, immersion heaters, space heaters and thermostats."

Westinghouse will employ from 150 to 200 persons in this new production unit, it was stated. The reconversion and remodeling of the plant will be begun immediately and production should be well under way by mid January.

Mr. McCully emphasized that the shifting of this manufacturing from the East Pittsburgh Works and the Mansfield, Ohio, Plant of the Electric Appliance Division would not affect total employment in either of these locations.

"Mansfield's heavy expansion of appliance production made the continued manufacture of thermostats, immersion and space heaters impossible," he explained. "At the East Pittsburgh Works increased activity in other lines of production by this division will more than make up for the transfer of the industrial heating manufacture."

## • *LATEST CATALOGS*

### Bailey Open Channel Meters

Bailey Meter Co., Cleveland 10, Ohio, has published Bulletin No. 62 featuring Bailey Open Channel Meters for sewage industrial wastes, sludge, and irrigation water. The meters described in this bulletin are of both the direct mechanical and the electronic telemeter type. A wide selection of registers having various combinations of indicating, recording and integrating features is illustrated. Alternate methods for mounting registers on wall, panel and pedestal are also shown.

All types of registers are said to be suitable for use with flumes, weirs, and atmospheric discharge nozzles. Outstanding features claimed are: Low Cost, Easy Installation, Self-cleaning, Availability of Automatic Control, Suitability for use in Flow Totalizing Systems.

### Weekly Wall Calendar

The large, easy to read giant numerals of each week are combined with the current, previous and following month.

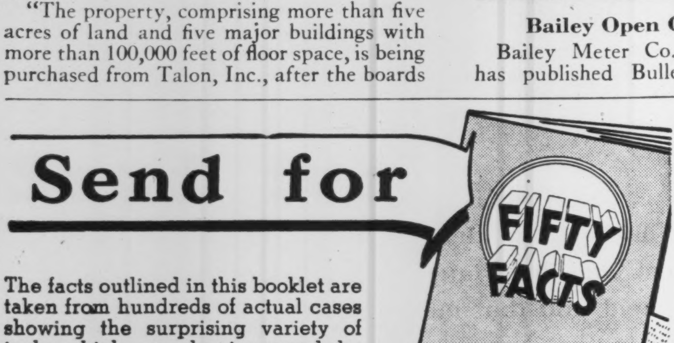
New style lettering adds to the legibility and attractiveness, combining all of the practical value of the popular 1945 editions and the beauty of the multi-colored Stan Ekman illustration.

This calendar includes, a section of technical data covering wire and sheet metal gauges, screw threads, etc., plus a full twelve month calendar all on one sheet.

1946 calendars are furnished free of charge. Address all requests to the Frederick Post Co., Box 803, Chicago 90.

### Permold Technical Bulletin

Written to provide designing engineers, production executives and metallurgists with reliable information on permanent-mold-castings, a new Reference Data Bulletin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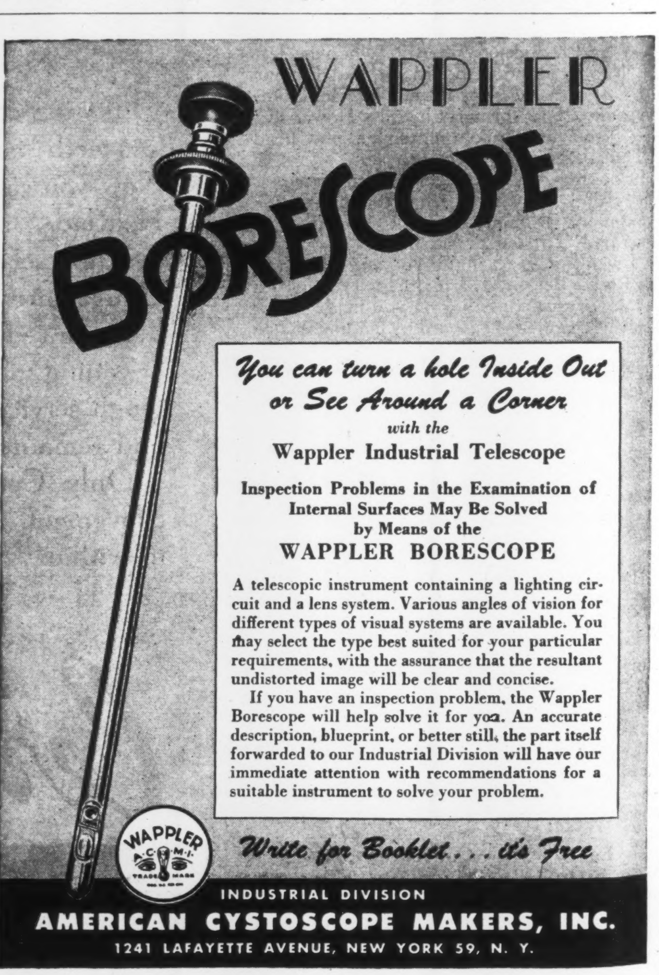

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## • Keep Informed

PMC 45 has recently been published by The Permold Co., Medina, Ohio.

This 20-page two-color review of permanent-mold-castings points out advantages obtainable with aluminum castings with respect to such matters as cost, design and strength. Suggestions are offered to the designing engineer to facilitate the designing of parts for the permanent-mold casting process.

The booklet includes four tables which give the nominal composition and physical properties of Permold aluminum base alloys and the nominal composition and physical properties of Permold aluminum base sand cast alloys. Herein is contained valuable information on how to achieve sound casting quality.

Various applications of permanent-mold-castings are illustrated by clear-cut photographs of many varied parts.

This booklet is especially desirable in that it offers clear-cut methods for obtaining the lowest piece price for each part at the point of assembly.

### Portable Vacuum Cleaners

The line of Exidust portable vacuum cleaners suited to the needs of almost every type of industrial plant, institution, transportation facility, and public or commercial building, is described in a new bulletin just issued by the Allen Billmyre Co. Dimensions, capacity, power, performance, and weights are given for all models and sizes.

Important characteristics of Exidust portable vacuum cleaners, such as the advanced design of the vacuum producer, the thorough dust separation, and the easy maneuverability, are explained in this bulletin.

The 10-page bulletin is extensively illustrated with explanatory photographs showing the portable Exidust cleaning floors, walls, crevices, machine parts, pipes, and other structures. The Exidust bulletin may be obtained by writing on a company letterhead to the Allen Billmyre Co., 431 Fayette Avenue, Mamaroneck, N. Y.

### Cellular Rubber

Four-page pamphlet, 845-21, describes various forms in which sponge rubber, bonded fibre and other sub-density materials are manufactured. Illustrates ninety-eight molded, die cut and fabricated shapes of flexible, elastic compressible products used for cushioning, shock absorption, vibration dampening, sealing, insulating, gasketing, etc. Sponge Rubber Products Co., Derby Place, Shelton, Conn.

### Useful Shaft Data

This booklet of handy data and short cuts should be a great time saver for any one whose work involves determination of required shaft sizes. It includes tables, curves and formulas for computing torque, deflection angle of thrust, bending moment, and other factors in solid, hollow, keywayed and stepped shafts. Complimentary copies may be had by writing on your business letterhead to the Worm Gear Division of the De Laval Steam Turbine Co., Trenton 2, N. J.

### Forged Ring Gaskets

"Gruv-Seal, Forged Iron and Alloy, Ring Gaskets" is the title of a new booklet published by the Steel Improvement and Forge Co., 970 East 64th Street, Cleveland, Ohio. The booklet gives complete information and buying data on forged gaskets made of ingot iron, nickel, chromium and monel metals. These gaskets are particularly suitable for high pressure and high temperature service,

*Continued on Page 46*

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